
Logistics Management Institute

**Performance Metrics for
Assessing Resource Utilization
in Business Areas
A Focus on Depot Maintenance**

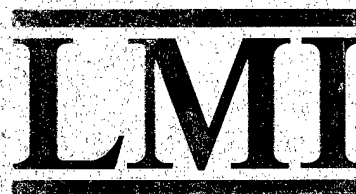
PA703R1

May 1999

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Performance Metrics for Assessing Resource
Utilization in Business Areas
A Focus on Depot Maintenance

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Executive Summary

Many Department of Defense (DoD) support organizations are financed with revolving funds to take advantage of their flexibility. However, in the appropriations-oriented Defense Programming Review, there has been little visibility of the internal financial operating plans of those support organizations and of the total funding that their customers plan to spend on them.

DoD is interested in developing performance metrics applicable to program analysis of defense support business areas. We identify key indicators geared toward this purpose.

Our research and findings focus on three specific performance metric areas: output, cost, and quality. In performing this research, we concentrated on identifying potential metrics in these three specific areas and evaluating the existing supporting data and its validity. We also observed the collected data, the metrics, and the potential indications of those data.

To minimize the disruption to Office of the Secretary of Defense activities, agencies, and the Services during the course of this task, it was decided that new data reporting requirements would be minimized. Therefore, we used existing data elements to the maximum extent possible. This constraint affects both historical and projected data.

Our findings and conclusions pertain to the two broad purposes of this task: (1) identifying potential metrics and evaluating the supporting data; and (2) observing the collected data, the associated metrics, and the potential indications of the metrics. The conclusions also include important cautions on the use of the resulting metrics.

We believe that the set of metrics areas (i.e., output, cost, and quality) we developed can be useful in conducting program analysis of the Depot Maintenance business area. The metrics can be linked with major success factors associated with the DoD's strategic goals and missions. These metrics, taken together, form

a reasonably good picture of resource-related trends in output and cost performance.

Sufficient data to construct the output and cost metrics are available in the Budget Estimate Submissions (BESs). Because of changes, to include transfers of missions between organizations, care must be exercised when extracting data to ensure a consistent baseline is being used.

Quality performance data are in a substantial shortfall. Not all Services adequately reported quality data in the Depot Maintenance Operations Indicators, and the BES does not include such data for any Service. Some organizations (e.g., Naval Sea Systems Command and the Marine Corps) are known to be resistant to such measures. The additional data from the depots will not necessarily remove resistance. It is possible that the increased cost of gathering more detailed data will not be recouped in an increased analysis capability.

We analyzed and summarized general overriding trends and noted specific trends, when appropriate. We stress that the performance metrics should provide insight into how well an organization is functioning but should not drive the organization's functions. There is always the danger that emphasis will be placed on improving the "scores" of the metrics, and that attention will be paid to improving the components of the metrics at the expense of other factors.

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Chapter 1

Introduction

OVERVIEW

Many Department of Defense (DoD) support organizations are financed with revolving funds to take advantage of the flexibility offered by them. However, in the appropriations-oriented Defense Programming Review, there has been little visibility of the internal financial operating plans of those support organizations and of the total funding that their customers plan to spend on them.

Additionally, even when estimates of available customer funding are made, customers may change their workload requirements for a variety of reasons, including changing priorities or national security requirements. The cost of these changes to customer requirements is not well understood. Also, the lack of coordinated plans for both support customers and support providers results in DoD's inability to provide effective oversight and management guidance of major support organizations financed through the revolving or working capital funds.

OBJECTIVE

DoD is interested in developing performance metrics applicable to program analysis of defense support business areas. In this report, we identify key indicators geared toward evaluating resource utilization during program reviews and at other times.

This is the first in a series of reports focusing on the various activities in the Defense Working Capital Fund (DWCF). In this report, we highlight the Depot Maintenance business area. Specifically, our research and findings focus on three specific performance metric areas requested by the sponsor. These areas include output, cost, and quality. In performing this research, we concentrated on identifying potential metrics in these three specific areas and evaluating the existing supporting data available and its validity. We also observed the collected data, the metrics, and the potential indications of those data.

RELATED RESEARCH

Concurrent with our Depot Maintenance business area research, we have begun a more broad review of the Supply Management business area of all the military services and the Defense Logistics Agency (DLA). This concurrent effort is being conducted with fewer research constraints in the early phases. This may then allow more potential performance metrics to be considered, at least initially, prior to

narrowing the focus of the research through the addition of constraints, such as immediate data availability.

We anticipate that in the subsequent efforts, due to fewer constraints, we will be able to place more emphasis on areas such as the following:

- ◆ Are the measures we developed linked well to key factors?
- ◆ What cautions do we have about the use of these measures (and these data) by senior analysts and managers?
- ◆ Are there emerging areas or practices that must now be measured that were not required, or even known, in the past? If so, how long will be required to develop a valid baseline?

We anticipate that following the completion of the Depot Maintenance and Supply Management business area research, subsequent research will be desired in other activity groups of the DWCF. These areas include, at a minimum, the Distribution and Transportation business areas.

CONSTRAINTS

To minimize the disruption to Office of the Secretary of Defense (OSD) activities, agencies, and the Services during the course of this task, it was decided that new data reporting requirements would be minimized. Therefore, it was necessary for the Logistics Management Institute (LMI) to use existing data elements to the maximum extent possible. This constraint affects both historical and projected data.

Chapter 2

Methodology

PERFORMANCE PERSPECTIVES

Our approach to determining appropriate performance measures began with a review of metrics literature, a review of DoD strategic documents emphasizing areas focusing on logistics, a review of performance measure documents submitted to OSD, and a matching of DoD focus areas to the perspectives highlighted in the literature. Then we collected available data and developed metrics based on the basis of those data.

We began by initiating a literature review. The literature review provided a common theme that insisted performance measures needed to be linked to the organization's strategic objectives to be effective tools for business improvement. The linkage is normally achieved by identifying performance measures that highlight accomplishment of key success factors. Such factors are required for the organization to achieve its strategic objectives.

Performance areas are measured for several reasons, such as for planning and budgeting, assessing operational improvements, allocating resources, and monitoring operations. According to Ammons, there are four categories of performance measures:¹

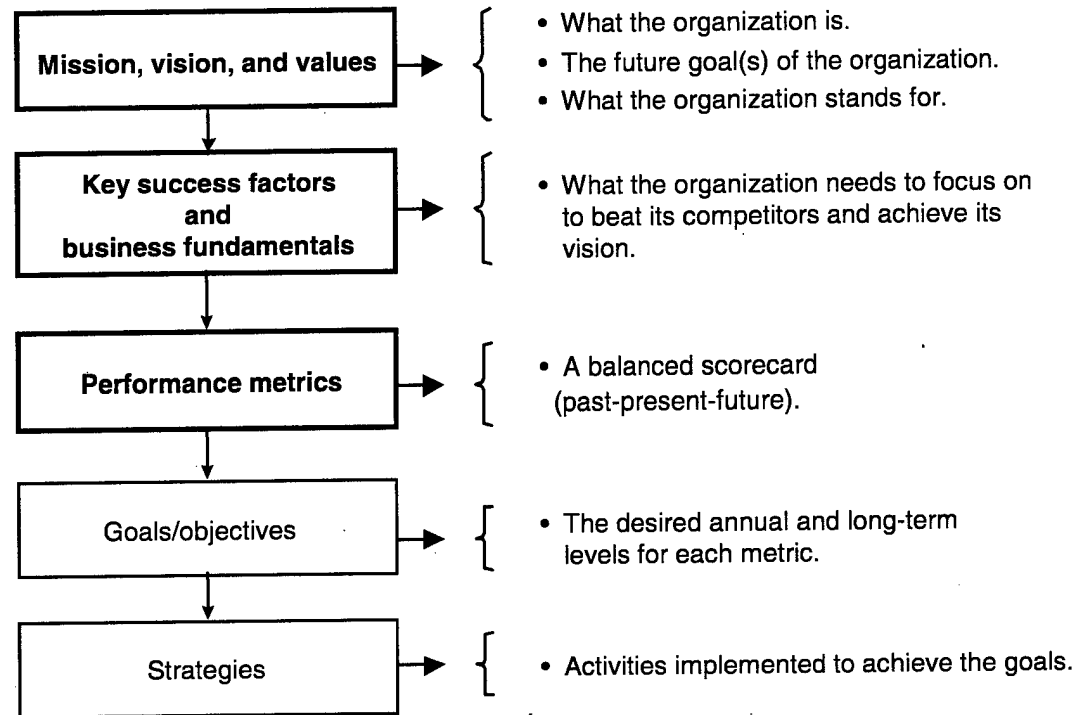
- ◆ *Workload measures*—indicate the amount of work performed or the amount of services received (e.g., number of items repaired).
- ◆ *Efficiency measures*—relate the work performed to the resources consumed to perform the work (e.g., cost per repair).
- ◆ *Effectiveness measures*—indicate the quality of performance by assessing the level of performance objectives achieved (e.g., percentage of correct repairs).
- ◆ *Productivity measures*—combine efficiency and effectiveness measures into one metric (e.g., unit cost per correct repair).

The “balanced scorecard” is a popular methodology that looks across functional areas within an organization (to ensure one function is not optimized at the expense of another) and ties the strategic objectives of the organization directly to

¹ David N. Ammons, *Municipal Benchmarks: Assessing Local Performance and Establishing Community Standards*. Thousand Oak, CA: Sage Publications, 1996.

the performance measures.² Figure 2-1 illustrates such a strategic measurement model that expands upon the balanced scorecard approach.³

Figure 2-1. Strategic Measurement Model



The first three steps in the process are emphasized in Figure 2-1. This highlights the areas addressed in our analysis. The goals, objectives, and strategies must be developed internally by the organization's management leaders (at many levels).

We used the model shown in Figure 2-1 as a guide for our analysis. First we identified and examined key DoD documents for the mission and values descriptions. Although the mission and values forming the foundation for a measurement system normally are developed through interaction with senior leaders, constraints of this analysis required that a review of the key documents capture this information. We next reviewed key Service and agency logistics plans and contracts to identify issues and areas on which to focus. That review identified the key success factors required to attain the strategic goals of the logistics community. The last step was to review other relevant data sources, as summarized in Table 2-1, to capture measurements already reported and to better understand the data already available. The relevant data sources to cover each of the first three steps in Figure 2-1 are summarized in Table 2-1.

² Robert S. Kaplan and David P. Norton, "Putting the Balanced Scorecard to Work," *Harvard Business Review*, September-October 1993, pp. 134-149.

³ Mark Graham Brown, *Keeping Score—Using the Right Metrics to Drive World Class Performance*. New York: Quality Resources, 1996.

Table 2-1. Measurement Data Sources

Measurement model step	Data source
Mission, vision, and values	<ul style="list-style-type: none"> • DoD <i>Logistics Strategic Plan</i> (1998) • DLA and Service strategic logistics plans • Defense Reform Initiative • DLA performance contract with Defense Management Council
Key success factors and business fundamentals	<ul style="list-style-type: none"> • Defense Science Board report on acquisition reform (March 1998) • Recent performance updates to service logistics leadership • Headquarters and National Inventory Control Point interviews • Past budget submissions
Performance metrics	<ul style="list-style-type: none"> • Past Program Objective Memorandum submissions • DLA performance contract with Defense Management Council • LMI research

As mentioned earlier, each literature source used some type of categorization method to group and identify the minimum areas that require measurement, such as the four mentioned earlier (workload, efficiency, effectiveness, and productivity). If businesses and organizations are viewed as transformational processes (transforming a given input into a desired output), then there are three measurement categories that relate inputs to outputs:

- ◆ Productivity (actual output/actual input)
- ◆ Utilization (capacity used/available capacity)
- ◆ Performance (actual output/standard output).

One popular method of identifying these metrics, ensuring they measure the impact on the organization as a whole (not just one department), and tying them back to the organization's strategic goals is the Balanced Scorecard. Although we do not implement the Balanced Scorecard methodology in this analysis, we used its principles to try to develop metrics that were meaningful across functional areas.

For example, one must look at performance measures from many viewpoints as indicated in Table 2-2:

Table 2-2. Performance Perspectives

Point of view	Question to ask of the organization	Performance measures
Financial	How do shareholders or sponsors perceive us?	<ul style="list-style-type: none">• Budget compliance• Return on investment
Customer	How do customers see us?	<ul style="list-style-type: none">• Customer ranking surveys• Order backlog
Internal	In what area must we excel?	<ul style="list-style-type: none">• Project close-out cycle• Rework
Growth/innovation	Can we continue to improve and create value?	<ul style="list-style-type: none">• Revenue from new sources

In addition to the points of view evidenced in Table 2-2, one might also measure employee satisfaction and supplier performance. Although not traditionally included in the Balanced Scorecard, these two areas have been receiving attention in recent studies.

Thus, it is important to look across functional areas within the organization, to ensure one department is not measured extensively and optimized at the expense of others. Additionally, it is important to establish linkages between performance metrics and the organization's strategic goals.

In the next chapter, we discuss the specific metrics that were developed and associated trends. Appendix A contains Service-specific results for each of the performance areas.

PERFORMANCE METRIC AREAS

The measurement literature points to a common theme that recommends performance measures be linked to the organization's strategic objectives.

In this report, we concentrate on three key depot maintenance performance areas: output, cost, and quality. These areas may be mapped as follows: output reflects workload measures, cost is used as an efficiency measure, and quality corresponds to effectiveness measures. Other categorization methods will be discussed; however, in each case, the three performance areas are easily mapped to the recommended categorization.

Outputs are defined as indicators of activity levels. In the depot maintenance environment, such outputs include labor hours, number of items processed, and profit

streams (for commercial maintenance enterprises).⁴ Outputs also may serve as normalization factors, to better compare between activities that may not be directly comparable.

The two major categories of *cost* we consider are operating costs and capital costs. Operating costs are funds expended to pay for the day-to-day operations of the facility, such as labor, materials, and utilities. Operating costs may provide indications of business base adequacy by identifying movement of labor hours from direct to indirect accounts, indicating lack of flexibility in labor management, for example. Distinctions between direct and indirect costs must be understood to properly calculate meaningful indicators. Capital costs are funds expended for procuring equipment, facilities, and other nonrecurring expenses. They can be used to analyze the amount of investment an activity is making. This can be viewed as an indicator of up-front investment to minimize future operating costs, both labor and material. In this analysis, we combine this performance metric with others to determine ratios such as throughput. Such ratios provide insight into the use that capital assets are receiving.

Measuring *quality* with quantitative metrics is often difficult. In this analysis, we investigated two aspects of quality: customer satisfaction and repair cycle time (timeliness and thoroughness of repairs). Often, the data are not directly available to measure quality, so surrogate data—with its inherent shortcomings—must be used instead. For example, data measuring repair thoroughness is rarely captured. However, if reliability data, such as mean time between failure data, are available, then adequate measures of quality often can be determined.

⁴ Labor hours are typically an input measure, but we used them as a surrogate for output. See our discussion in Chapter 3.

Chapter 3

Analysis

As stated earlier, this analysis concentrates on three key depot maintenance performance areas: output, cost, and quality. Each is discussed in a section that follows. Data sources and results associated with each metric also are explained.

OUTPUT

Direct labor hours (DLH) were used as the output metric. DLH is traditionally an input measure, but it can also be used to assess output, since DLH can be used as a surrogate for measurement of the “standard item repaired,” the ideal output measure. To compute standard item repaired, detailed data on the number of individual items of equipment repaired must be collected. Additionally, several standard hours to make each type of repair to each type of equipment must be available. With this information, hours and items can be interchanged with a simple conversion. These data were unavailable; therefore, DLH was selected as the surrogate. Additionally, DLH is an item-independent metric. It measures total hours consumed and does not discriminate between the types of items repaired. Finally, DLH highlights activity-level changes that can be used to normalize other measures. This point will become more evident as subsequent metrics are examined.

In a constant workload environment, the standard objective is to reduce DLH. This often is achieved by capital investments in equipment to reduce labor hours or process improvements to improve efficiency. We reemphasize that any metric, when assessed in isolation, may promote illogical behavior, and DLH is no exception. Actions to drive DLH down must be balanced with the “reactions” in other areas. These other areas will be discussed later in this report.

Sometimes, an increasing DLH is acceptable, for example, when hours move from overhead to DLH. This causes DLH to increase but decreases the ratio of operating expense to DLH.

Data

The data sources for this metric (and all other metrics discussed in this report) were the Depot Maintenance Operations Indicators (DMOI) and the Budget Estimate Submission (BES). The DMOI reports direct labor hours expended for item repair, by depot. These historical data were summarized to the service level for the analysis. The BES data are projections of DLH for the budget years and were extracted from the FY99 BES. DMOI data were used to display metrics for the

period FY93 to FY96. BES data then were used to show DLH projections from FY97 to FY99.

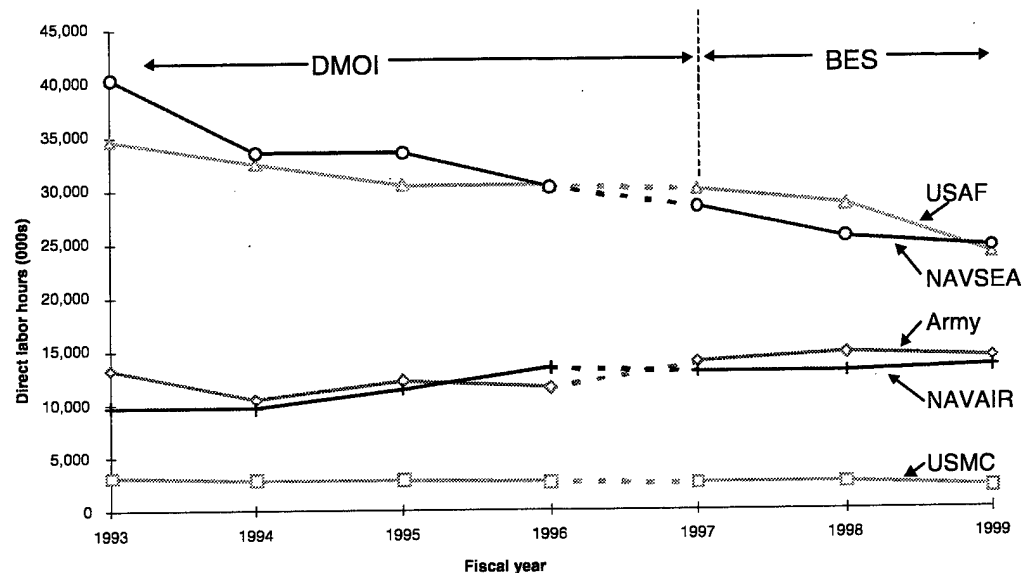
A problem with BES data is that not all Services report military labor hours associated with depot operations. For example, the Army included military manpower in direct labor totals while the Air Force DLH aggregates were not found in the BES. Therefore, only civilian direct labor was used in the analysis and was computed from BES detailed displays. The data for the services that explicitly reported military labor hours highlighted that the military hours are dwarfed by the civilian labor hours and that the error associated with this omission would be small.

An additional problem was that the Navy did not consistently report closing shipyards' and depots' hours in FY97. The BES data did not allow this to be corrected and, therefore, is a factor that must be considered when reviewing the metrics.

Results

The DMOI and BES data for DLH were graphed for each Service. The Navy data were reported for both Naval Air Systems Command (NAVAIR) and Naval Sea Systems Command (NAVSEA), so each was graphed separately. Figure 3-1 shows the DLH for each Service.

Figure 3-1. Direct Labor Hours



Note: USAF = U.S. Air Force; USMC = U.S. Marine Corps.

Because each Service has different workload levels, different accounting systems, and different reporting requirements, the data displayed in Figure 3-1 (and all other graphs in this report) are not directly comparable between the Services. Our goal is to explore the relative trends that are exhibited and note where the Services may either show similar patterns, or where substantial divergence is evident.

Figure 3-1 shows the DLH for the Air Force and NAVSEA are showing a downward trend, the Army and NAVAIR are slightly increasing, and the Marine Corps DLH has remained relatively flat, with a slight decrease.

For the Army, a substantial (approximately 25 percent) decrease in workload occurred early in the reported period, from FY93 to FY94. This is not unexpected due to the significant drawdowns in the early 1990s. A smooth transition does not take place during the transition from DMOI to BES data. The Army's subsequent rise in DLH is due to BES data that include munitions depot maintenance, which is not included in the DMOI data. Since the BES data are not reported at the depot level, specific depots' data cannot be removed. In summary, the Army DLH trend is not an area of concern.

The Air Force's DLH decreased at a relatively constant rate (approximately 5 percent per year). The transition point from the DMOI data to the BES data appears to be smooth, which is the desired behavior. Unlike the Army data, it appears that the Air Force DMOI and BES data are directly comparable. Additionally, the downward trend is a first-level indicator of actions being taken to reduce DLH.

NAVAIR data indicated that workload increased in the FY94 to FY96 time frame and is predicted to remain constant through FY99. The transition from DMOI to BES data is smooth.

The NAVSEA output data indicate that workload is decreasing at a consistent rate over the time frame plotted, with the transition between DMOI and BES data being seamless.

The USMC data indicate that workload is decreasing at a slow, yet constant rate, with a somewhat larger drop planned for FY99. Again, the transition from DMOI to BES is also smooth.

OPERATING COST

Two metrics were developed for operating cost. The first is the sum of direct labor costs (DLCs) and overhead costs (we define these two components together as the operating expense), divided by (DLH), as shown in Equation 3-1.

$$\frac{(\text{Direct labor cost} + \text{Overhead cost})}{\text{Direct labor hours}} = \text{Metric \#1.} \quad [\text{Eq. 3-1}]$$

This metric reflects total cost, excluding direct material, per DLH. The focus is on costs controllable by the depot. Material costs are a pass-through cost not controlled by the depot, and therefore are not included.

The second metric was overhead cost divided by DLH (Equation 3-2):

$$\frac{\text{Overhead cost}}{\text{Direct labor hours}} = \text{Metric \#2.} \quad [\text{Eq. 3-2}]$$

The combination of these two metrics captures the total nonmaterial cost changes. Therefore, these metrics isolate the changing elements that are controlled by the depots. Additionally, when these metrics are studied in combination with the DLH output metric, one can get an indication of business base requirements. For example, if Equation 3-1 shows an increasing trend and DLH has remained constant, then costs are increasing. If, simultaneously, Equation 3-2 shows a decreasing trend, then the combination of these three metrics that includes DLH, isolates direct labor costs as the increasing component.

The desired trend is for operating expenses to increase at a slower rate than throughput (total gross sales less materials) in an increasing-workload environment. That means in a constant-workload environment, the goal is for operating expenses to decrease. Such performance results from reducing the overhead components of labor and materials and reducing direct labor through efficiency increases. A danger lies in focusing on this metric and reducing DLH alone. The result is that the ratio of operating expense to DLH will increase and an incorrect conclusion could be drawn. Thus, we emphasize that metrics and trends need to be evaluated as a set of information so that the correct conclusions can be drawn.

Data

The DMOI reports a single line item for operating expenses, which are total costs less direct materials. Therefore, operating expenses are composed of direct labor, indirect labor, and indirect materials. That means that the numerator in Equation 3-1, although described as the sum of two components, was captured by the operating expense line item of the DMOI. However, not until FY96 was overhead reported directly in the DMOI. Since the DMOI does not itemize the overhead components separately, overhead could not be computed for years prior to FY96. Therefore, Equation 3-2 could not be computed prior to FY96. Again, all cost in this report are presented in current year dollars.

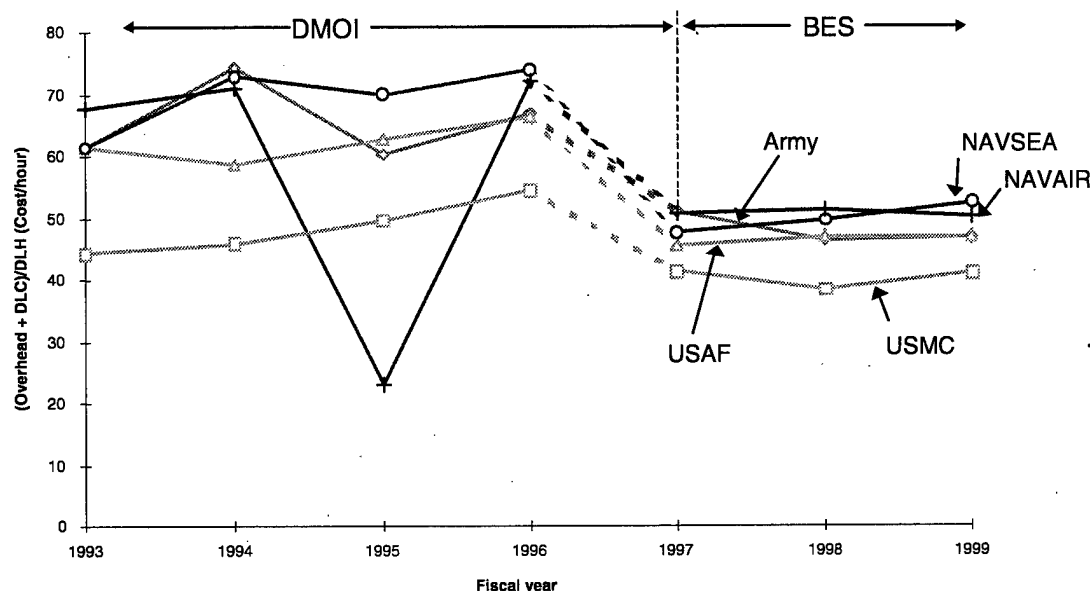
The BES reports direct labor, indirect labor, and general and administrative (G&A) labor separately, so the numerator of Equation 3-1 was computed when BES data were used. However, indirect materials were not included in BES data, but they were in the DMOI values. Therefore, when comparing the numerator for Equation 3-1, we must realize that the BES and DMOI data are not directly comparable.

As noted earlier, the BES did not report overhead as a separate line item, so it was computed for Equation 3-2 as the sum of indirect and G&A labor. Again the BES data do capture indirect materials while the DMOI overhead value does not capture this element.

Results

The two operating cost metrics are graphed in Figure 3-2 and Figure 3-3 for each Service. For the first metric ($[Direct\ labor\ cost + Overhead\ cost]/DLH$), Figure 3-2 illustrates that the DMOI data exhibited much wider swings in magnitude, while the BES data are relatively flat and of similar magnitude for each Service. This may be an indication that the indirect material costs included in the DMOI values have a wider variance than the direct and overhead costs. However, in each case, the BES data are less than the DMOI data, as would be expected.

Figure 3-2. Operating Expense/DLH

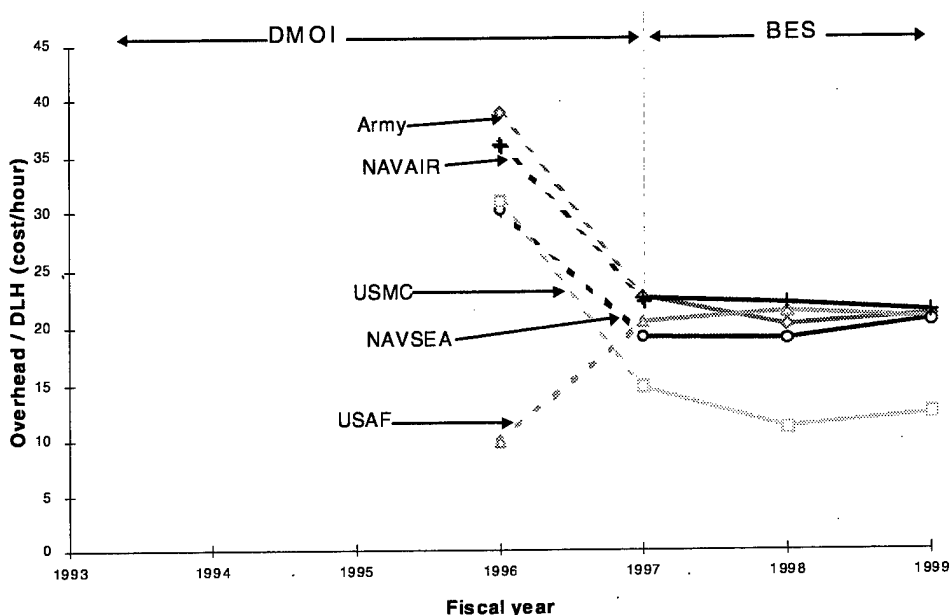


The NAVAIR FY95 datapoint departs significantly from an otherwise consistent FY93 to FY96 trend. Further investigation found that the operating expense reported in the third quarter of FY95 was negative for all three NAVAIR entities. The data will not be changed; however, this data point should be ignored.

Next, we need to look at the data for the second metric (see Figure 3-3), so that comparisons between the two metrics can be made and meaningful assertions will be possible. Figure 3-3 shows the results of graphing *Overhead cost/DLH* for each Service. (As noted above, data were only available beginning in FY96.) One overwhelming trend appears to be the decrease in value, and then a general leveling off, for all Services except the Air Force, which shows and increase and then a leveling off. However, we refrain from drawing any conclusions at this time, since we only have 1 year of reported DMOI data, compared with 3 years of computed BES values. A partial explanation of the large drop in $(Direct\ labor\ cost + Overhead\ cost)/DLH$ from DMOI to BES data may be that the DMOI values for overhead include indirect material costs, while the BES data do not. The relatively

flat values in the BES period may indicate, as similarly discussed under Figure 3-2 that the indirect material costs included in the DMOI values have a wider variance than the overhead costs.

Figure 3-3. Overhead Cost/DLH



Now we will discuss Service-specific observations, for both Figure 3-2 and Figure 3-3.

For the Army, the change of the DLH baseline (the BES data include munitions depot maintenance, but DMOI data do not) has caused the BES data to be generally lower than the DMOI data. The *Operating expense/DLH* and *Overhead cost/DLH* indicate that the Army depots do well in an increasing-workload environment (FY97–FY98). When DLH increases, if both overhead and DLC increase proportional to DLH, the *Operating expense/DLH* curve would be flat. However, since the curve slopes downward, operating expenses are increasing at a slower rate than DLH. Similarly, the downward sloping *Overhead cost/DLH* line indicates that overhead is also increasing at a slower rate than DLH.

Trends in decreasing workload for the Army depot are not as favorable. *Operating expense/DLH* does not increase dramatically in FY98–FY99 when DLH increases. This indicates that operating expenses are reduced at about the same rate as the workload decrease. The slight growth shown by the *Overhead cost/DLH* line, in combination with the almost flat line for *Operating expense/DLH* indicates that overhead is decreasing less rapidly than DLH. In fact, these curves indi-

cate that DLC is potentially decreasing faster than DLH, and overhead is becoming the more substantial component, which is not a desired outcome.

Overhead, as an individual data element, was reported only for a subset of the Air Force depots in the DMOI. Therefore, the FY96 *Overhead cost/DLH* data point is not valid. Focusing on the FY97–FY99 time frame, DLH decreases in both periods. For the period FY97–FY98, *Overhead cost/DLH* and *Operating expense/DLH* rise, indicating that at least overhead is not decreasing at the rate of DLH. The FY98–FY99 line segments indicate that overhead begins to decrease more rapidly than DLH, but DLC does not decrease as fast as DLH. The combination of these two effects indicates that DLC does not decrease at a rate proportional to DLH.

For NAVAIR, if the FY95 and FY96 data were averaged, the trend for operating expenses and *Operating expense/DLH* would be a decreasing function—that average data point would be the same as the FY97 BES computed point. Because *Operating expense/DLH* and *Overhead cost/DLH* remain constant or decrease while DLH increases, NAVAIR is doing well controlling its expenses.

When DLH either increases or decreases, one would desire both *Operating expense/DLH* and *Overhead cost/DLH* to decrease. This is not the case with the NAVSEA data. During FY97–FY98, *Overhead cost/DLH* is constant but *Operating expense/DLH* increases. This indicates that DLCs are not decreasing at the same rate as DLH, which means that there may be a problem with DLC. During FY98–FY99, *Overhead cost/DLH* increases, indicating that overhead is not decreasing at the same rate as DLH, which is a potential problem. This may be a case where the workload may be constant but labor hours are just being reclassified as overhead from the direct category.

For the Marine Corps, we see that the more substantial drop in FY98–FY99 DLH did not have a corresponding decrease in overhead. It appears that DLC decreased (at least proportionally to DLH), but overhead did not decrease proportionately.

CAPITAL COST

Two metrics were developed for capital cost. The first is the *Capital effectiveness ratio*, defined as throughput divided by depreciated capital asset value. For our purposes, throughput is calculated as revenue less direct material cost, as shown in Equation 3-3.

$$\frac{\text{Revenue} - \text{Direct material cost}}{\text{Depreciated capital asset value}} = \text{Metric \#3.} \quad [\text{Eq. 3-3}]$$

The metric described by Equation 3-3 represents the “value added” by the depot, per unit of asset value. For example, the increase in value of a repaired item over a damaged item is due to two components: the repairs added and the labor required to install these items. The depot does not control the cost of materials (a

pass-through cost to the depot) but does control the labor component. This is the value added being captured in this measure.

The second metric is simply the measure of *Net capital investment* during the period. The DMOI reports this value as “capital assets,” so for DMOI data, the incremental year-to-year change was used. That is, DMOI reports total capital each period, so the net capital inventory was calculated as $DMOI_{i+1} - DMOI_i$. The BES did not report this metric directly, so the net capital investment value had to be calculated with given BES data, as shown in Equation 3-4:

$$\text{Program year authority} - \text{Depreciation} = \text{Metric \#4} . \quad [\text{Eq. 3-4}]$$

Net capital investment represents the degree of modernization and the resources put toward the infrastructure required to support the mission. This second metric, *Net capital investment*, is used to allow for the separation of capital-only increases from throughput-only decreases.

Capital investments are not always intended to increase throughput, but may be made to decrease operating expenses. Increasing investment causes the ratio of throughput to capital to decrease—however, there is no impact on revenue (the customer does not pay a different price), and there is no direct material change. Instead, operating expenses and overhead may decrease in relationship to DLH. Investments can be effectively used to decrease labor requirements. Again, this emphasizes the need to examine all metrics, not one metric in isolation.

Data

The *Capital effectiveness ratio* is reported directly in the DMOI. The DMOI nomenclature is “capital investment effectiveness.” Additionally, depreciated assets are reported directly in the DMOI. However, we calculate the ratio, since throughput (the numerator of Equation 3-3) and depreciated capital asset value is directly reported in the DMOI. As stated earlier, all financial data in this report are presented in current year dollars.

The BES reports capital investment and depreciation separately for each period. Only the incremental, not the cumulative, investment is reported so Equation 3-4 is used to calculate the *Net capital investment*. Subsequently, Equation 3-4 also serves as the denominator for Equation 3-3 when BES data are used. Additionally, only equipment values and real property maintenance (RPM) investment are represented in the BES—military construction (MILCON) is not. For DoD, equipment and RPM capture approximately 70 percent of capital investments. Also, the only equipment investments reported in working capital fund (WCF) budgets are for replacement items; new equipment requirements are funded by the customer or system program office imposing the requirements. Therefore, BES data may be under-reporting capital investments, compared with the DMOI data. These differences may help us to understand some of the results below.

A key reason for establishing performance measurements is to develop insight into specific business areas and to enact control on components of the measures

when they are seen to be exceeding acceptable limits. However, for depot maintenance, new mission requirements (buildings and equipment) are not elements under depot control and, therefore, depot management should not be judged on these areas. MILCON is a separate appropriation and is not part of WCF BES. Equipment for new missions is part of the equipment systems funding stream (also not a part of WCF BES).¹

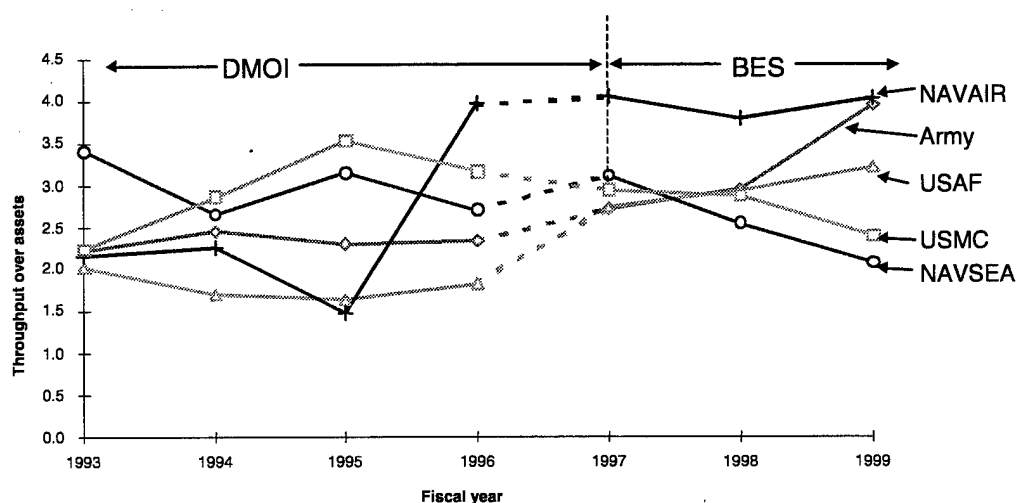
Only replacement and repair requirements (for buildings and equipment) are cost elements that a depot can control. The BES capital investments data capture equipment replacement procurement and RPM.

Therefore, capturing only replacement equipment and RPM encompasses only about 70 percent of the investment. However, these items are essentially 100 percent of the investment controlled by the depots. The capital investment baseline will not affect the direction of the trends shown in the graphs—only the slope (rate of change) of the lines.

Results

The two capital cost metrics are graphed below for each Service. Neither the *Capital effectiveness ratio* (Figure 3-4) nor the *Net capital investment* (Figure 3-5) metrics exhibited any overriding trends. One observation is that the BES data for capital investment in Figure 3-5 appear to be “tighter” with less variance than the DMOI data. Service-specific results are presented in the paragraphs that follow.

Figure 3-4. Capital Effectiveness Ratio

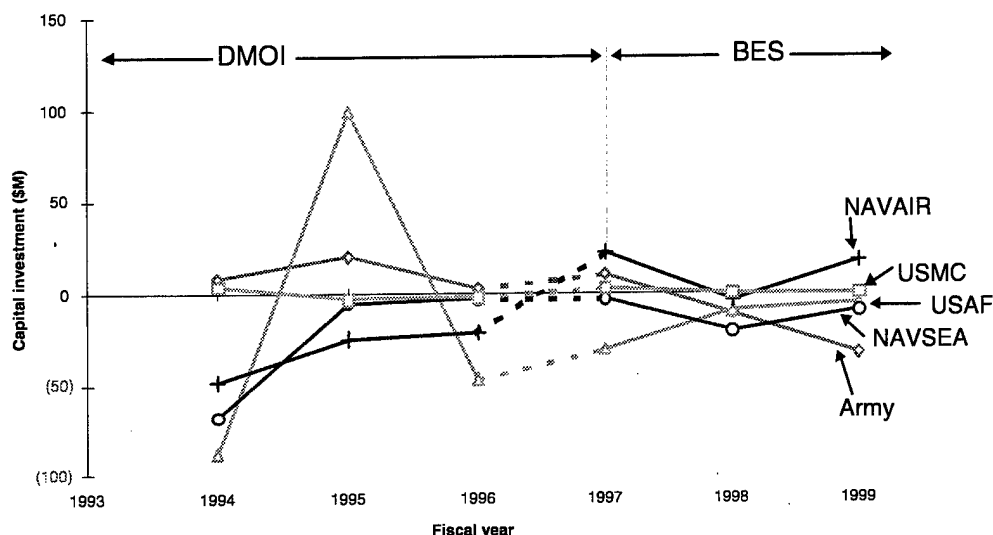


The Army's *throughput* (revenue less direct materials) increased from the DMOI data to the BES data because ordnance depots were included in the BES, but not the DMOI. From FY97 to FY99, *Net capital investment* decreased. With this in mind, the data indicate that while not replenishing the capital replacement fund (i.e., net investment decreased), throughput rose. We cannot isolate the contribu-

¹ New equipment is about 25 percent of total equipment.

tion to throughput that is new mission or new equipment that is “free issue” to the depot; however, these data could inspire one to investigate this further.

Figure 3-5. Net Capital Investment



Air Force throughput increased significantly from DMOI to BES data points. We verified our computations but could not uncover a clear reason for this jump. All that can be said is that the trend is an increase of the capital effectiveness ratio, even in years of negative net investment. This indicates the maintainability or improvement of throughput with a negative “capital flow,” at least temporarily in the time frame studied.

NAVAIR’s capital cost performance was “middle of the road.” One observation is that throughput tended to increase with low net investment. However, in later years, throughput did not increase substantially by the increased positive net investment.

NAVSEA did not show promising capital cost performance. Generally, throughput decreased while capital investment was consistently negative. The resulting indication is that throughput decreased at a greater rate than capital assets.

The Marine Corps’ performance also was not encouraging. The most recent data indicate a decreasing trend in throughput, while capital investment hovered around zero. The observation is that throughput decreased at a greater rate than assets.

QUALITY

Two metrics were developed to measure quality. The first is *schedule conformance*, defined as the number of items completed on time, divided by the number of items scheduled. Equation 3-5 shows this relationship.

$$\frac{\text{Number of items completed on time}}{\text{Number of items scheduled}} = \text{Metric \#5.} \quad [\text{Eq. 3-5}]$$

Equation 3-5 captures customer satisfaction quality, since not meeting schedule results in a ripple effect to depot customers, present and future. Since this metric is a percentage, only an increase in its value is an acceptable change.

A major shortfall with this metric is that schedule conformance weights each work order equally, whether that work order is for a single item or a large "lot" of items. However, more detailed data would require a significant data collection effort.

The second metric is *in-repair time*, defined as the total item-days in repair, divided by the number of items completed. This metric also is described as DMOI process days.

We do not recommend using this second metric, since the product mix can cause a significant change in the metric value. For example, one would be adding disparate items such as tanks and rifles without any type of normalization process. Changing a depot's workload from tank repair to small arms repair would cause a significant change in the metric value; however, the mix of the systems is not within the depot's control.

Data

The DMOI reported "schedule indicator" data were used directly for schedule conformance. However there are concerns with some of the Services. NAVSEA does not report schedule indicator data because NAVSEA defines units completed as ships, the largest depot-level repairable. Since the number of units (ships) completed in a given time frame is so low compared with standard product lines, this indicator would give misleading or inaccurate results.

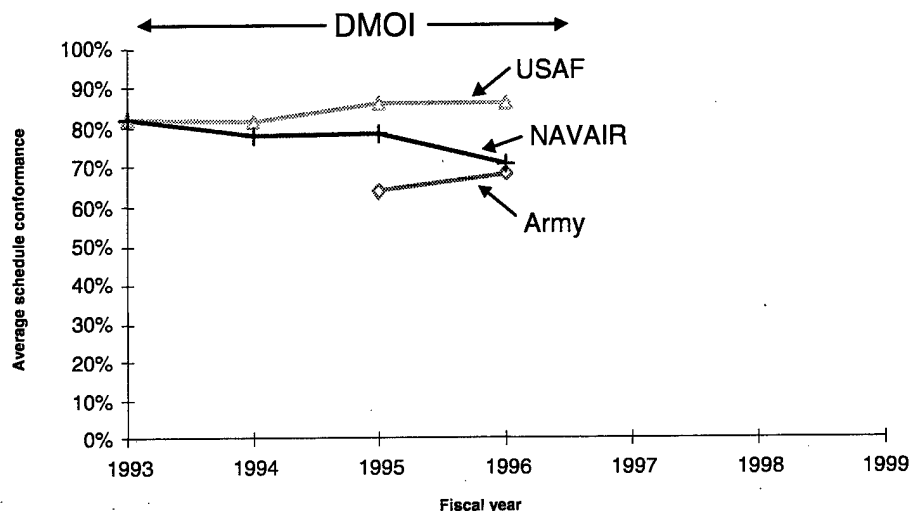
The Marine Corps also does not report the schedule indicator since it does not have the maintenance float that allows the Fleet Marine Forces (FMF) to issue weapon systems and receive replacements to satisfy Table of Equipment (TE) shortages. Therefore, in most cases, the FMF operates TE deficient until depot maintenance is completed and the weapon is returned. The Army did not report this data in FY93 and FY94.

The BES does not contain data that are comparable, so no projections were made.

Results

Since there were only two data points for the Army, we can only review the Air Force and NAVAIR data for trends shown in Figure 3-6. These are discussed in the Service-specific paragraphs below.

Figure 3-6. Schedule Conformance



The Army's average schedule conformance increased from FY95 to FY96; however, with only two data points available, it would be premature to call this a trend.

The Air Force schedule conformance appears to have increased. However, noting the scale of the graph, the change is approximately 5 percent, so quality may be considered constant prior to and following the jump in the FY94–FY95 time frame.

NAVAIR's schedule conformance decreased from FY93 to FY96 by approximately 13 percent. This metric indicates an undesirable trend and highlights an area for improvement, based on the available historical data.

As discussed above, NAVSEA and the Marine Corps do not report schedule data, since their end items and logistics systems cause such data to be misrepresentative of true depot performance.

Chapter 4

Findings, Conclusions, and Cautions

Our findings and conclusions pertain to the two broad purposes of this task: (1) identifying potential metrics and evaluating the supporting data; and (2) observing the collected data, the associated metrics, and the potential indications of the metrics. This chapter also includes some important cautions on the use of the resulting metrics.

POTENTIAL METRICS AND SUPPORTING DATA

We believe that the set of metrics areas (output, cost, and quality) presented in this report can be useful in conducting program analysis of the Depot Maintenance business area. The metrics can be linked with major success factors associated with the Department's strategic goals and missions. These metrics, taken together, form a reasonably good picture of resource-related trends in output and cost performance.

Sufficient data to construct the output and cost metrics is available in the BESs. Because of changes, to include transfers of missions between organizations, care must be exercised when extracting data to ensure a consistent baseline is being used. In some cases, the baseline will change and the detailed information to correct the data may not be available. At this point, one must make it clear to the users of the data so invalid conclusions will not be drawn. We conclude that analysis of output and cost can be done without additional data.

We found quality performance data to be a substantial shortfall. Not all Services adequately reported quality data in the DMOI, and the BES does not include such data for any Service. Some organizations (i.e., NAVSEA and the Marine Corps) are known to be resistant to such measures. The additional data from the depots will not necessarily remove resistance. It is possible that the increased cost of gathering more detailed data will not be recouped in an increased analysis capability.

GENERAL OBSERVATIONS ABOUT THE DEPOT MAINTENANCE BUSINESS AREA

We analyzed general overriding trends and noted specific trends, when appropriate. A summary of the findings is as follows:

- ◆ Generally, we saw that all activities except NAVAIR were experiencing decreasing workload. The Army's increase was caused by more depots reporting in the BES data than in DMOI.
- ◆ The Army exhibited positive capital-effectiveness trends. The Army had more difficulty balancing direct and indirect costs in a decreasing-workload environment than in an increasing-workload environment.
- ◆ The Air Force showed overhead cost decreases that were more than proportional to DLH decreases, when DLH dropped substantially. Also, the Air Force's direct labor costs did not appear to decrease at a rate consistent with DLH changes.
- ◆ NAVAIR's direct labor costs and overhead costs both increased at a rate no greater than DLH increases. However, DLH did increase, especially in the FY94 to FY96 time frame.
- ◆ NAVSEA experienced consistently decreasing DLH over the entire time frame analyzed. Overall, NAVSEA's capital effectiveness decreased, but its net investment was negative. This begs the question of whether the decrease might have been caused by the lack of investment.
- ◆ The Marine Corps had a decreasing workload, most significantly in the FY98 to FY99 time frame. Capital effectiveness decreased overall, during a period with relatively no net capital investment.

We stress that comparisons among these organizations are essentially invalid, since the data sources, reporting requirements, and other variables differ, resulting in data values that cannot be compared directly. The trends (i.e., increasing or decreasing metric levels) are the only basis for comparison.

CAUTIONS

We offer the following cautions:

- ◆ The three depot maintenance performance areas are part of a larger depot maintenance system; that system itself is part of an even larger system. Like all complicated systems, it is difficult to analyze subsets in isolation. Interactions with other systems are important. For depot maintenance, these interactions include supply management and transportation.

- ◆ We stress that the performance metrics should provide insight into how well an organization is functioning, but should not drive the organization's functions. There is always the danger that emphasis will be placed on achieving an improved score in a measured area. In this scenario, attention will be paid to improving the performance on components of the metrics, at the expense of other factors.
- ◆ Only items under the control of the organization should be measured. Measuring things outside the control of management is futile and distracting, since management cannot necessarily change or improve the drivers of the metric.
- ◆ Metrics should not be static, but should be continuously reviewed to ensure relevant inputs and outputs are measured and that the metrics provide information that is useful.
- ◆ No single metric should be presented and evaluated in isolation. This "family" of metrics needs to be considered in combination, so that context and interrelationships can be fully understood.

Appendix A

Detailed Data and Analysis

Graphs for individual Services are presented in this appendix. The data and results discussion in the main body of the paper are repeated verbatim in this section, following each applicable graph.

The individual Service results are presented for each of the following metrics:

- ◆ Output
- ◆ Operating Cost
- ◆ Capital Cost
- ◆ Quality.

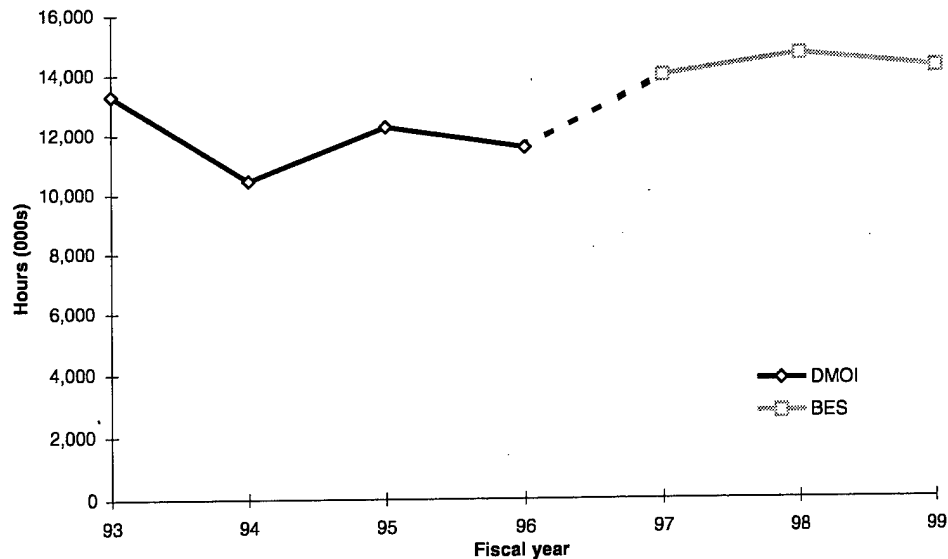
For each metric, the results are listed for the Army, Air Force, NAVAIR, NAVSEA, and the Marine Corps, respectively.

OUTPUT

The following graphs present the output metric results, in terms of DLH.

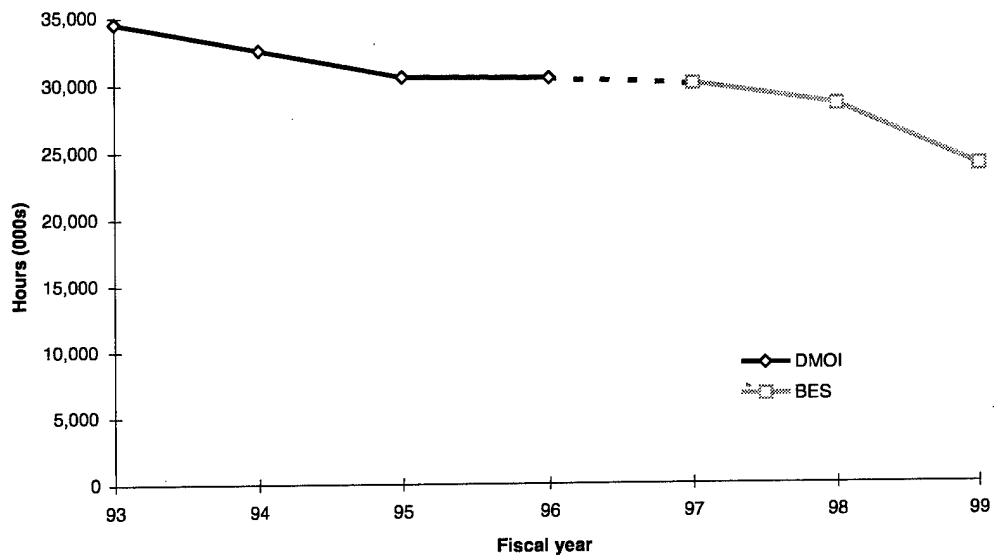
For the Army (Figure A-1), a substantial (approximately 25 percent) decrease in workload occurred early in the reported period, from FY93–FY94. This is not unexpected due to the significant drawdowns in the early 1990s. The transition from DMOI to BES data is not smooth. The Army's subsequent rise in DLH is due to BES data that includes munitions depot maintenance, which is not included in the DMOI data. Since the BES data do not report at the depot level, specific depots' data cannot be removed. In summary, the Army DLH trend is not an area of concern.

Figure A-1. Direct Labor Hours—Army



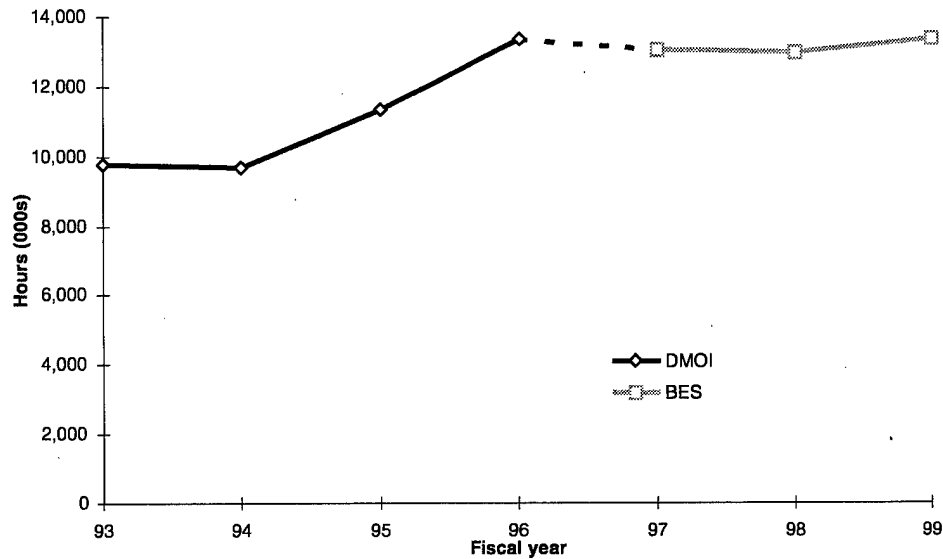
The Air Force's DLH decreased (Figure A-2) at a relatively constant rate (approximately 5 percent per year). The transition point from the DMOI data to the BES data appears to be smooth, which is the desired behavior. Unlike the Army data, it appears that the Air Force DMOI and BES data are directly comparable. Additionally, the downward trend is a first-level indicator of actions being taken to reduce DLH.

Figure A-2. Direct Labor Hours—Air Force



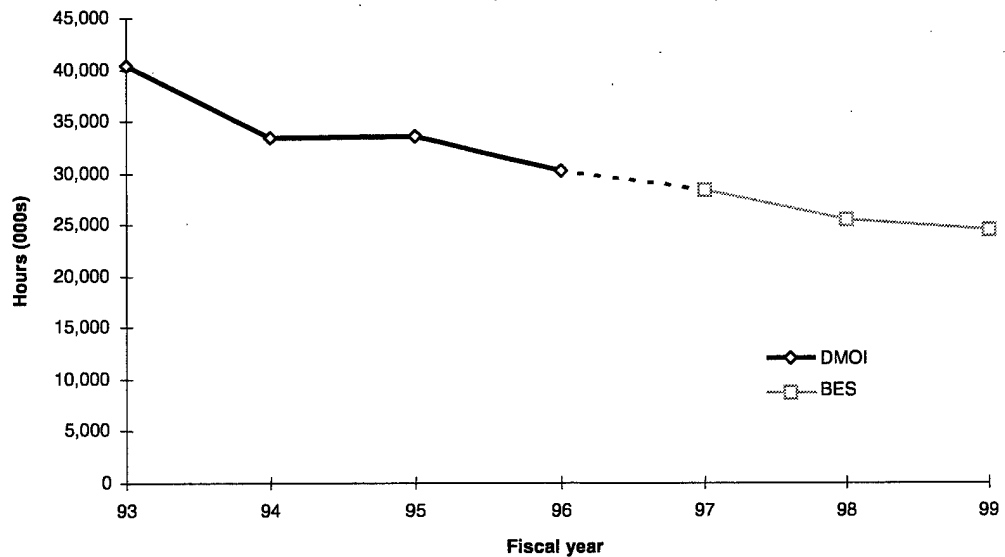
NAVAIR data (Figure A-3) indicated that workload increased in the FY94–FY96 time frame and is predicted to remain constant through FY99. The transition from DMOI to BES data is smooth.

Figure A-3. Direct Labor Hours—NAVAIR



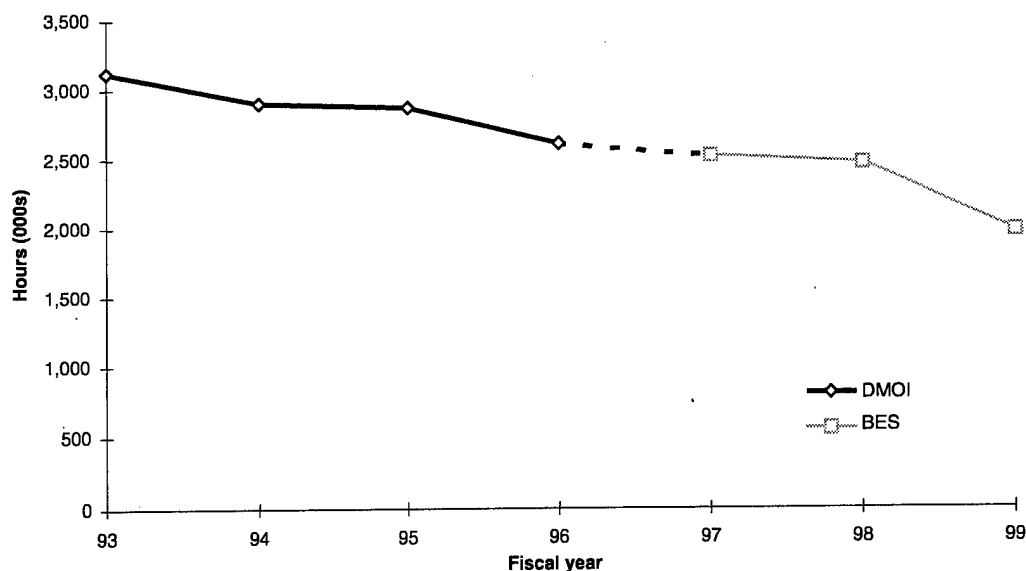
The NAVSEA output data (Figure A-4) indicate that workload is decreasing at a consistent rate over the time frame plotted, with the transition between DMOI and BES data being seamless.

Figure A-4. Direct Labor Hours—NAVSEA



The USMC (Figure A-5) data indicate that workload is decreasing at a slow, yet constant rate, with a somewhat larger drop planned for FY99. Again, the transition from DMOI to BES also is smooth.

Figure A-5. Direct Labor Hours—Marine Corps



OPERATING COST

The two operating cost metrics were *Operating expense/DLH* and *Overhead cost/DLH*. Each is graphed below for each Service.

For the Army (Figures A-6 and A-7), the change of the DLH baseline (the BES data include munitions depot maintenance, but DMOI data do not) has caused the BES data to be generally lower than the DMOI data. The *Operating expense/DLH* and *Overhead cost/DLH* indicate that the Army depots do well in an increasing-workload environment (FY97 to FY98). When DLH increases, if both overhead and DLC increase proportional to DLH, the *Operating expense/DLH* curve would be flat. However, since the curve slopes downward, operating expenses are increasing at a slower rate than DLH. Similarly, the downward sloping *Overhead cost/DLH* line indicates that overhead is also increasing at a slower rate than DLH.

Figure A-6. Operating Expense/DLH—Army

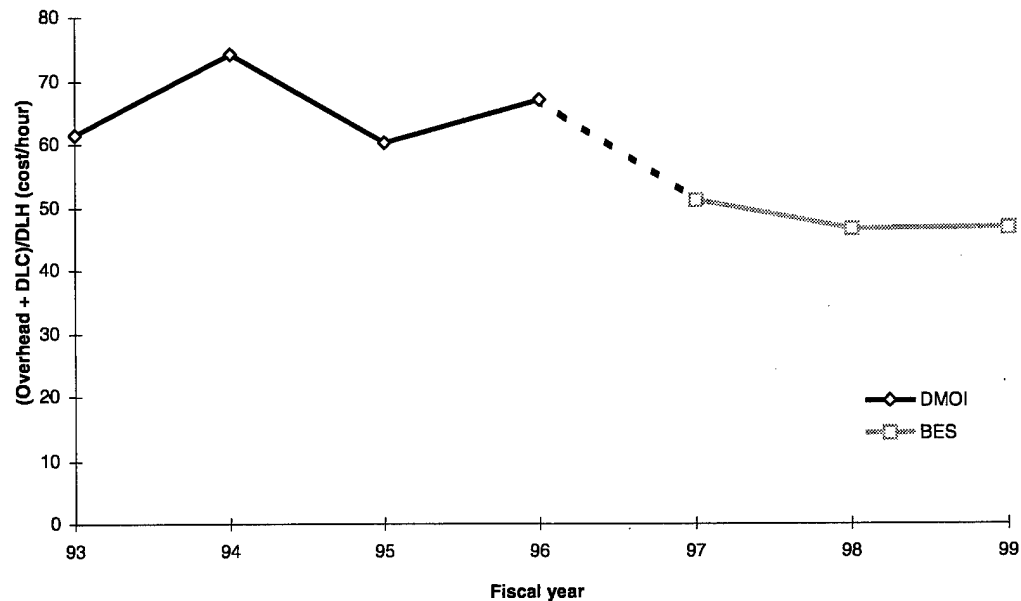
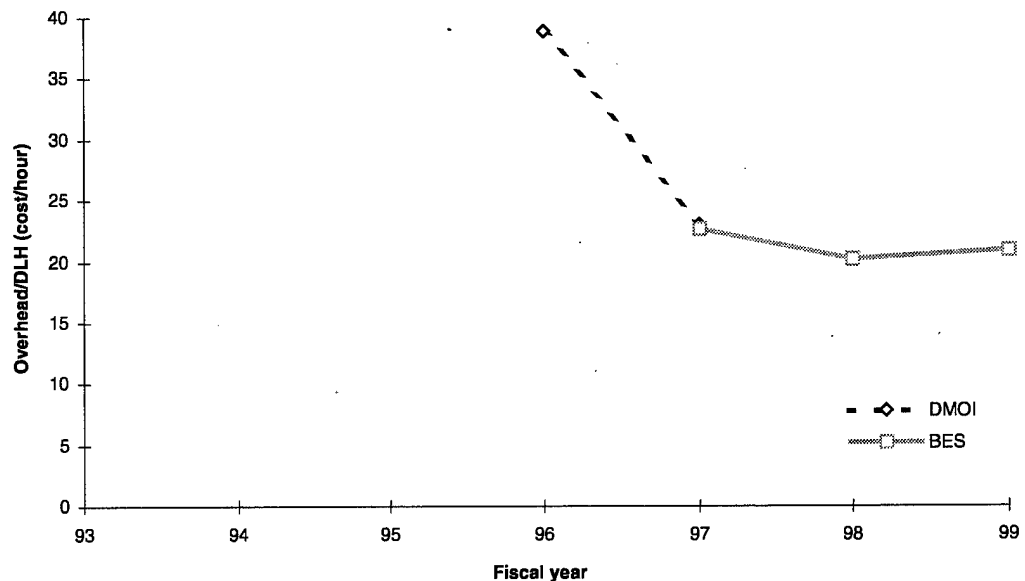


Figure A-7. Overhead Cost/DLH—Army



Trends in decreasing workload for the Army depot are not as favorable. *Operating expense/DLH* does not increase dramatically in FY98–FY99 when DLH increases. This indicates that operating expenses are reduced at about the same rate as the workload decrease. The slight growth shown by the *Overhead cost/DLH* line, in combination with the almost flat line for *Operating expense/DLH* indicates that overhead is decreasing less rapidly than DLH. In fact, these curves indicate that DLC is potentially decreasing faster than DLH, and overhead is becoming the more substantial component, which is not a desired outcome.

Overhead, as an individual data element, was reported only for a subset of the Air Force depots in the DMOI (Figures A-8 and A-9). Therefore, the FY96 *Overhead cost/DLH* data point is not valid. Focusing on the FY97–FY99 time frame, *DLH* decreases in both periods. For the period FY97–FY98, *Overhead cost/DLH* and *Operating expense/DLH* rise, indicating that at least overhead is not decreasing at the rate of *DLH*. The FY98–FY99 line segments indicate that overhead begins to decrease more rapidly than *DLH*, but *DLC* does not decrease as fast as *DLH*. The combination of these two effects indicates that *DLC* does not decrease at a rate proportional to *DLH*.

Figure A-8. Operating Expense/DLH—Air Force

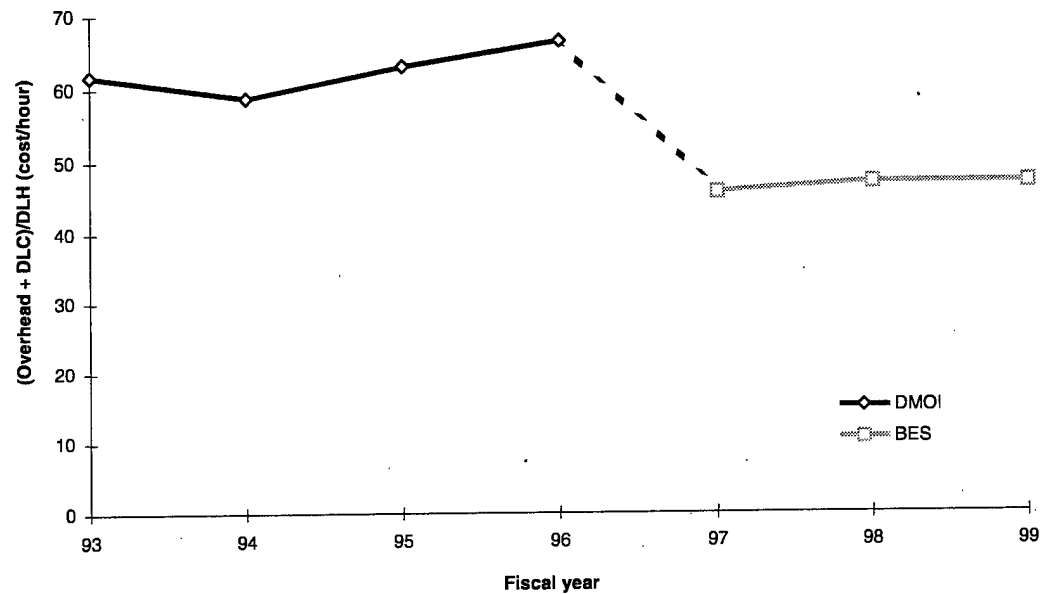
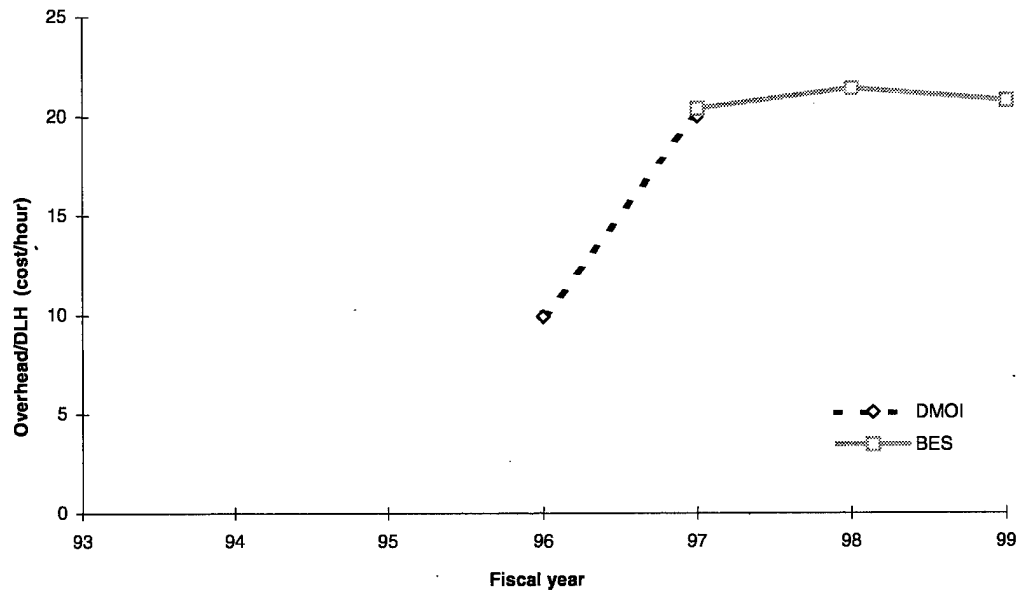


Figure A-9. Overhead Cost/DLH—Air Force



For NAVAIR (Figures A-10 and A-11), if the FY95 and FY96 data were averaged, the trend for operating expenses and *Operating expense/DLH* would be a decreasing function—that average data point would be the same as the FY97 BES computed point. Because *Operating expense/DLH* and *Overhead cost/DLH* remains constant or decreases while DLH increases, NAVAIR is doing well controlling its expenses.

Figure A-10. Operating Expense/DLH—NAVAIR

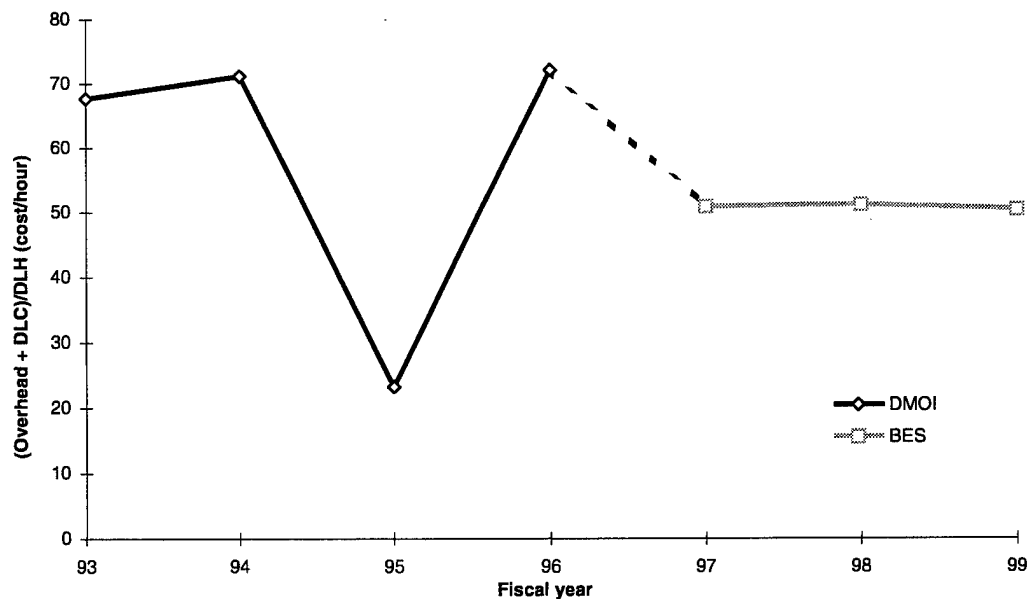
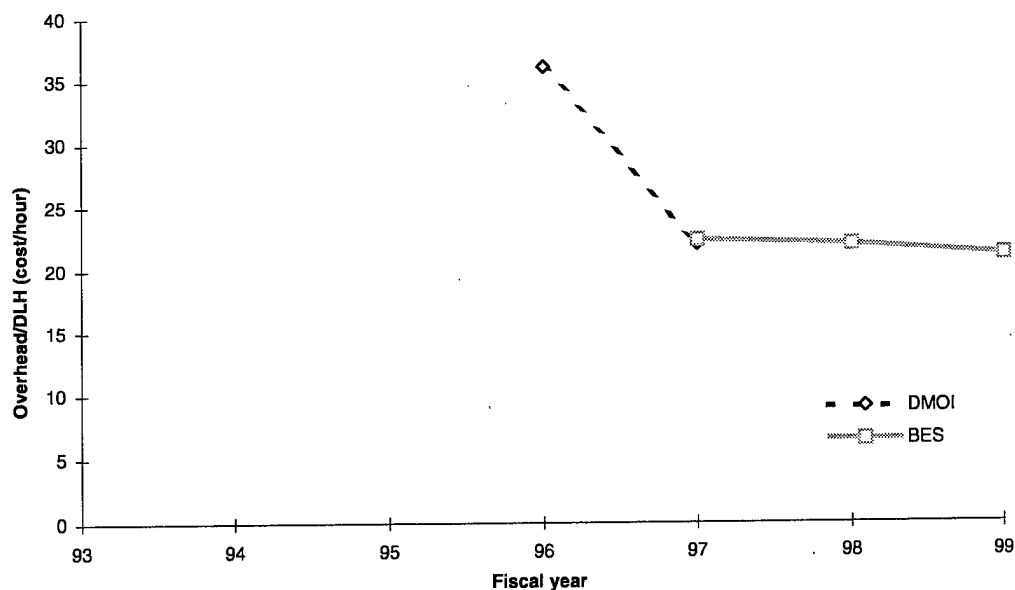


Figure A-11. Overhead Cost/DLH—NAVAIR



The NAVAIR FY95 datapoint departs significantly from an otherwise consistent FY93 to FY96 trend. Further investigation found that the operating expense reported in the third quarter of FY95 was negative for all three NAVAIR entities. The data will not be changed; however, this data point should be ignored.

When DLH either increases or decreases, one would desire both *Operating expense/DLH* and *Overhead cost/DLH* to decrease. This is not the case with the NAVSEA data (Figures A-12 and A-13). During FY97–FY98, *Overhead cost/DLH* is constant but *Operating expense/DLH* increases. This indicates that DLCs are not decreasing at the same rate as DLH, which means that there may be a problem with DLC. During FY98–FY99, *Overhead cost/DLH* increases, indicating that overhead is not decreasing at the same rate as DLH, which is potentially a problem. This may be a case where the workload may be constant but labor hours are just being reclassified as overhead from the direct category.

Figure A-12. Operating Expense/DLH—NAVSEA

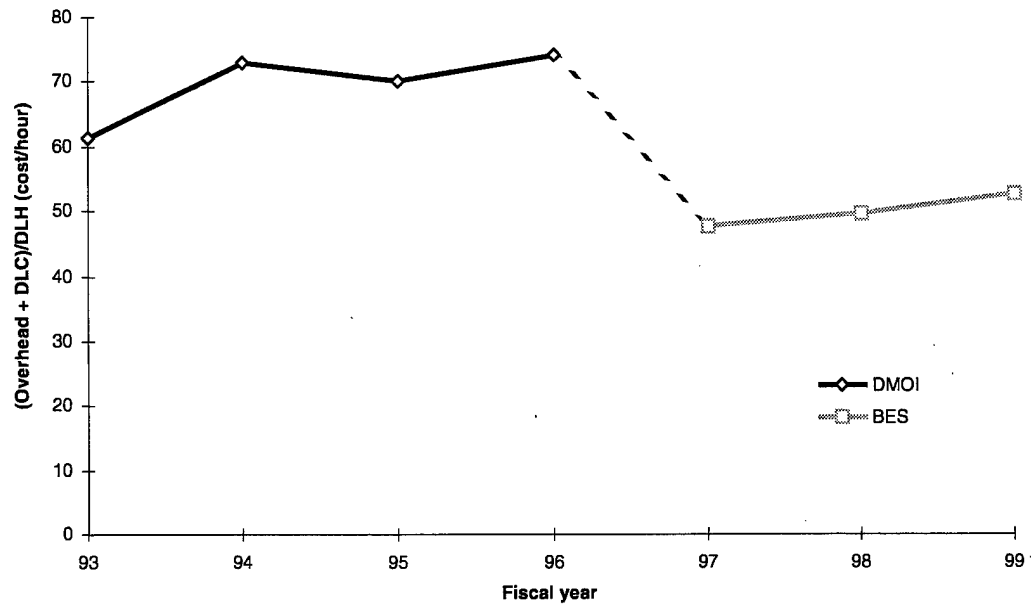
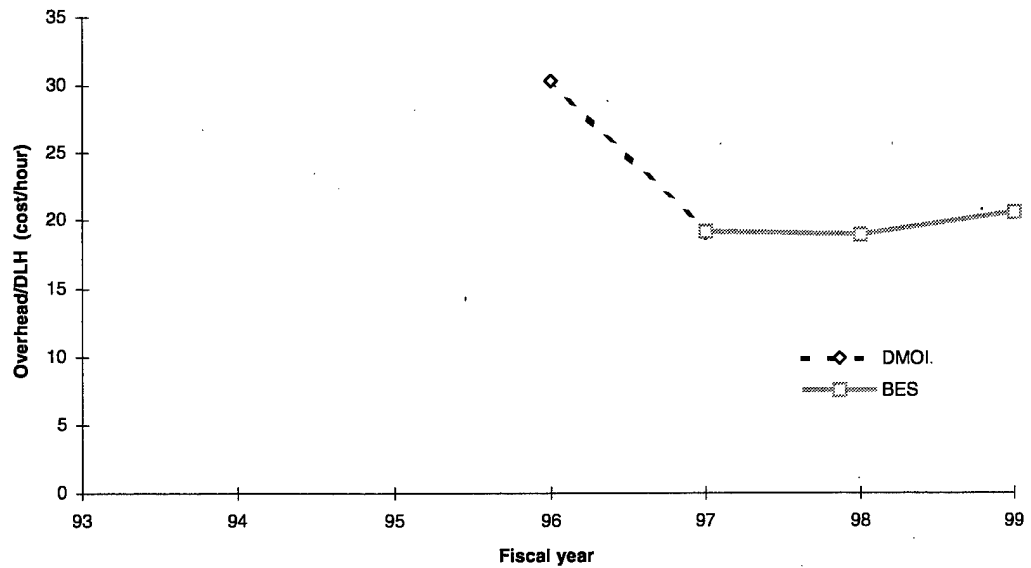


Figure A-13. Overhead Cost/DLH—NAVSEA



For the Marine Corps (Figures A-14 and A-15), we see that the more substantial drop in FY98–FY99 DLH did not have a corresponding decrease in overhead. It appears that DLC decreased (at least proportionally to DLH), but overhead did not decrease proportionately.

Figure A-14. Operating Expense/DLH—Marine Corps

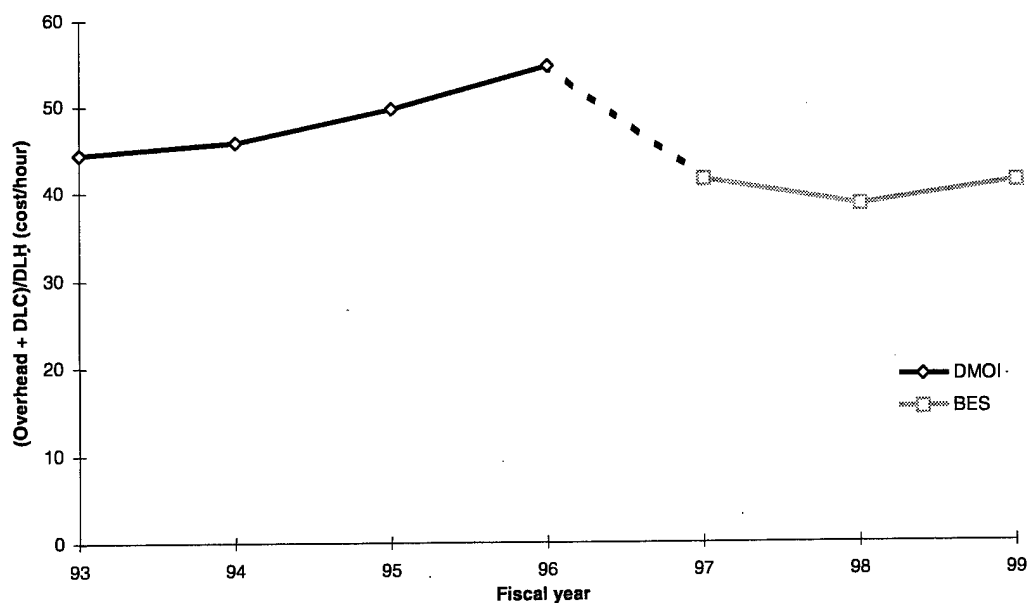
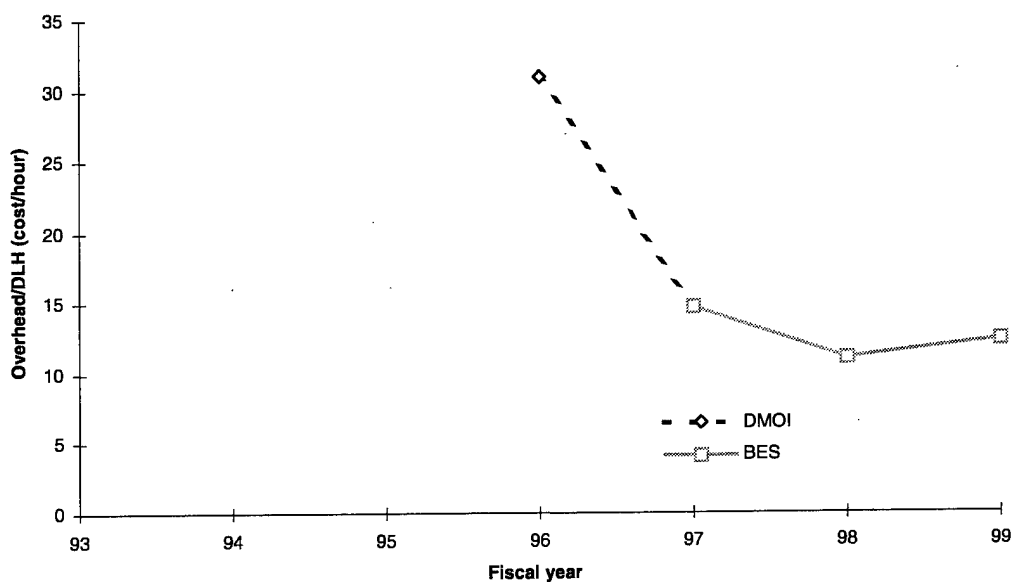


Figure A-15. Overhead Cost/DLH—Marine Corps



CAPITAL COST

The two capital cost metrics are graphed below, for each Service.

The Army's (Figures A-16 and A-17) *throughput* (revenue less direct materials) increased from the DMOI data to the BES data because ordnance depots were included in the BES, but not the DMOI. From FY97–FY99, *Net capital investment*

decreased. With this in mind, the data indicate that while not replenishing the capital replacement fund (i.e., net investment decreased), throughput rose. We cannot isolate the contribution to throughput that is new mission or new equipment that is "free issue" to the depot; however, these data could cause one to investigate this further.

Figure A-16. Capital Effectiveness Ratio—Army

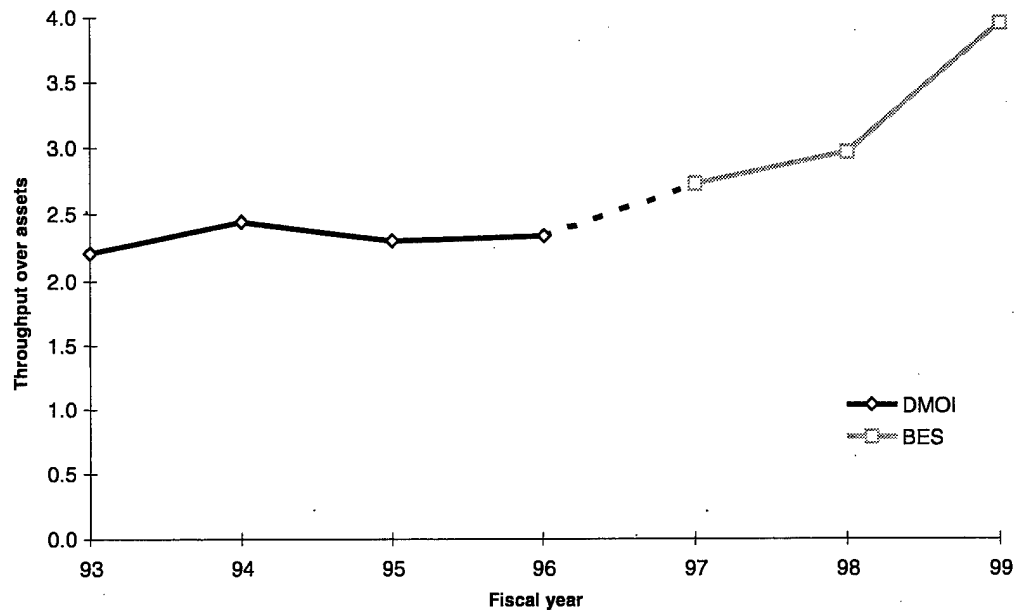
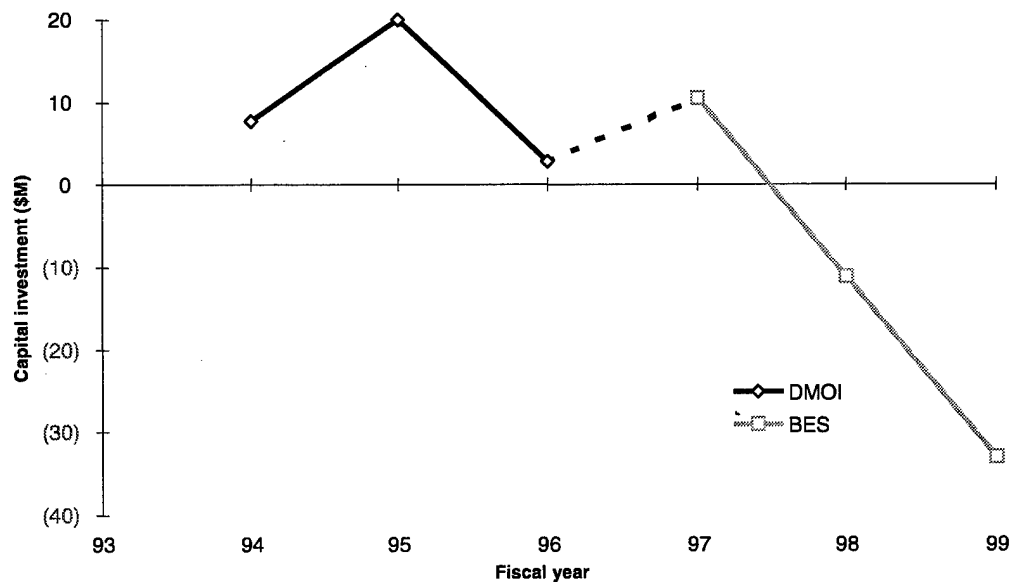


Figure A-17. Net Capital Investment—Army



Air Force throughput increased significantly from DMOI to BES data points (Figures A-18 and A-19). We verified our computations but could not uncover a clear reason for this jump. All that can be said is that the trend is an increase of

the *Capital effectiveness ratio*, even in years of negative net investment. This indicates the maintainability or improvement of throughput with a negative “capital flow,” at least temporarily in the time frame studied.

Figure A-18. Capital Effective Ratio—Air Force

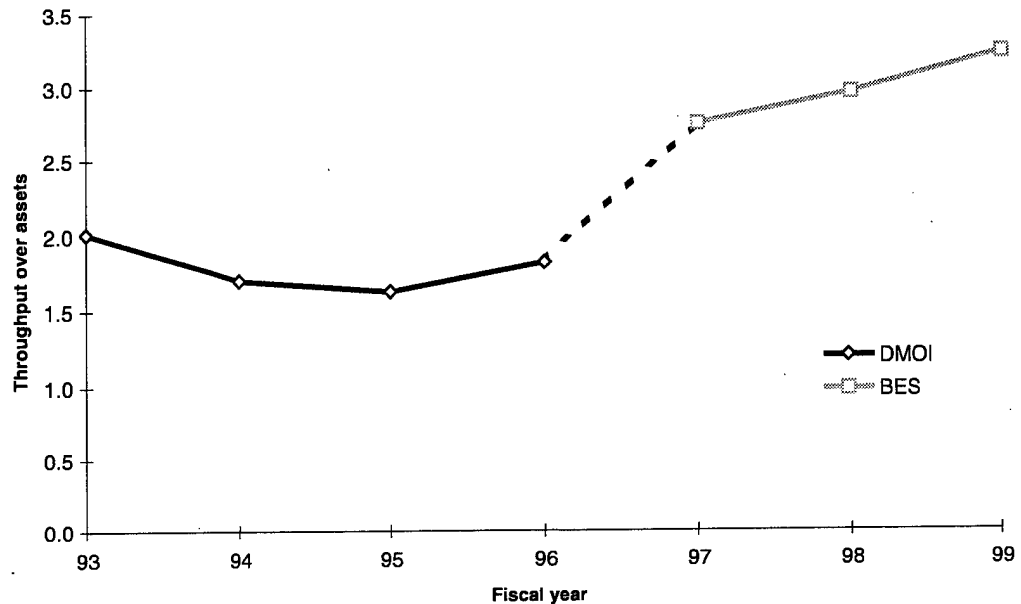
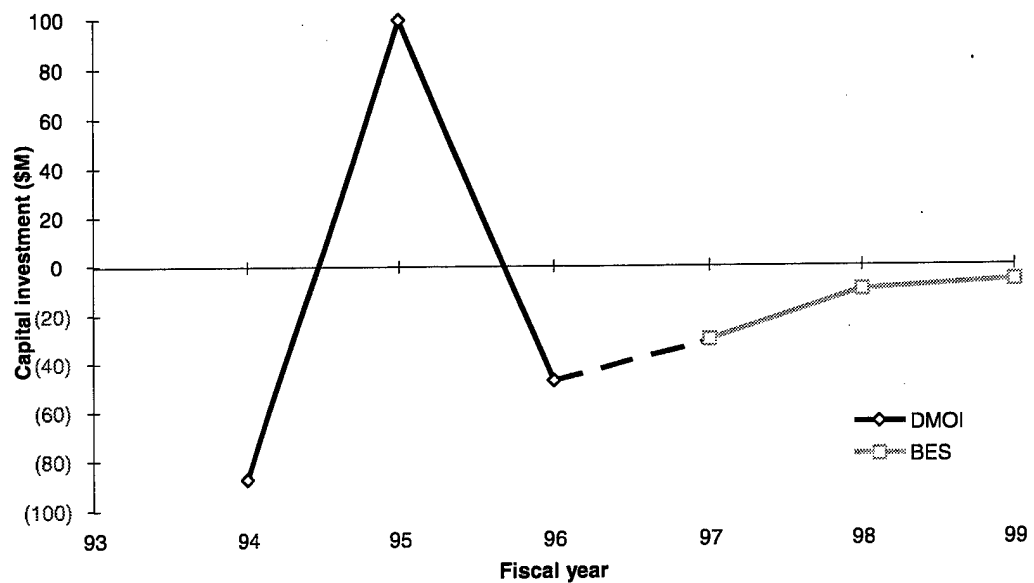


Figure A-19. Net Capital Investment—Air Force



NAVAIR’s capital cost performance was “middle of the road” (Figures A-20 and A-21). Throughput tended to increase with low net investment. However, in later

years, throughput did not increase substantially by the increased positive net investment.

Figure A-20. Capital Effectiveness Ratio—NAVAIR

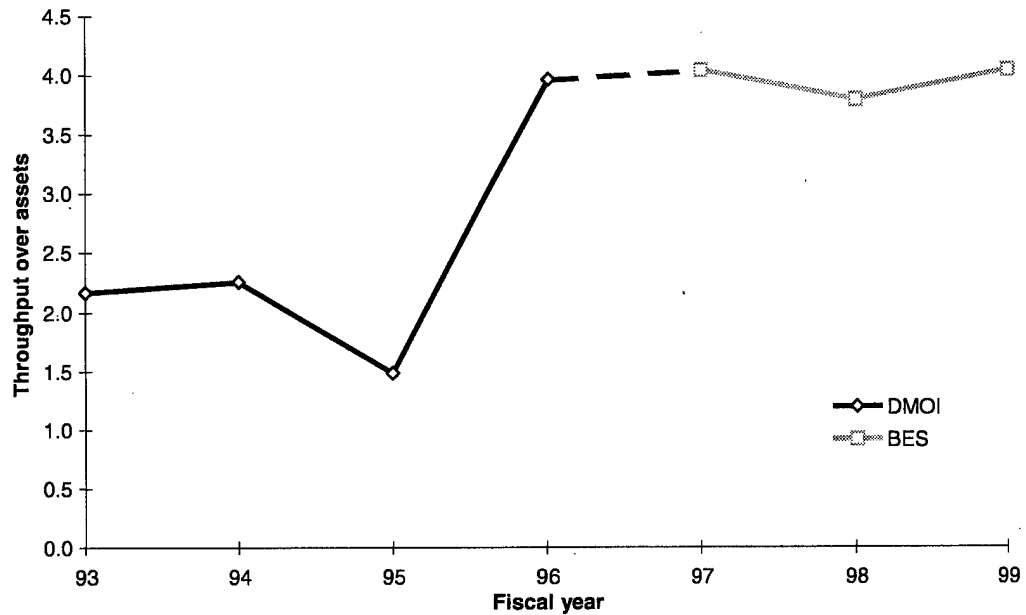
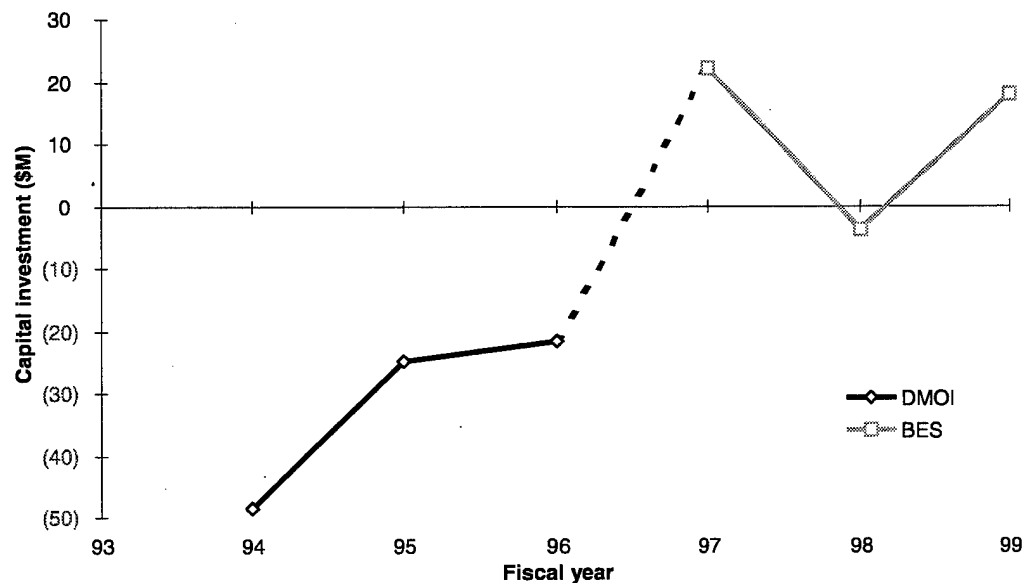


Figure A-21. Net Capital Investment—NAVAIR



NAVSEA did not show promising capital cost performance (Figures A-22 and A-23). Generally, throughput decreased while capital investment was consistently negative. The resulting indication is that throughput decreased at a greater rate than capital assets.

Figure A-22. Capital Effectiveness Ratio—NAVSEA

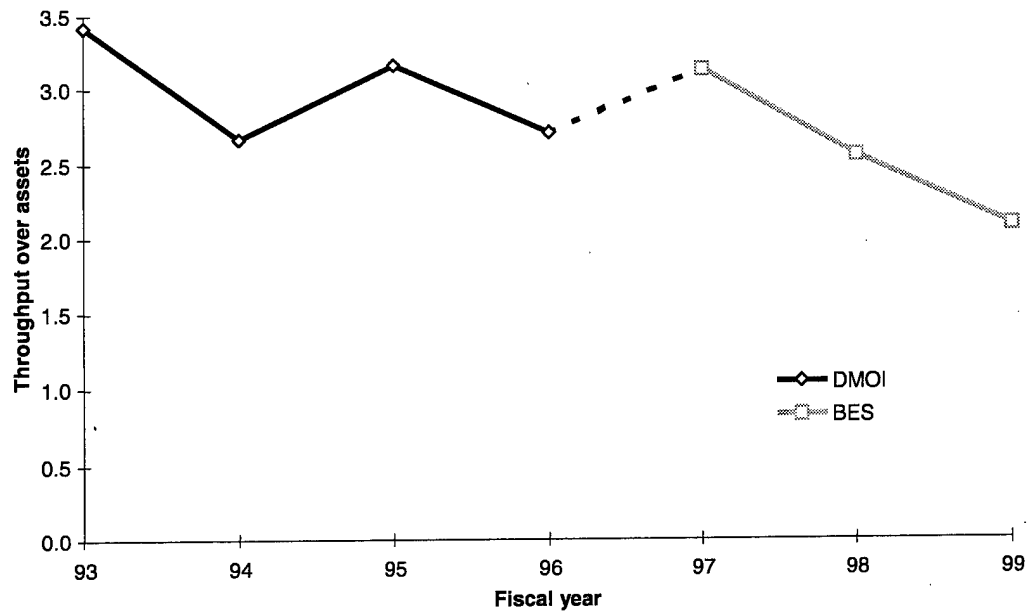
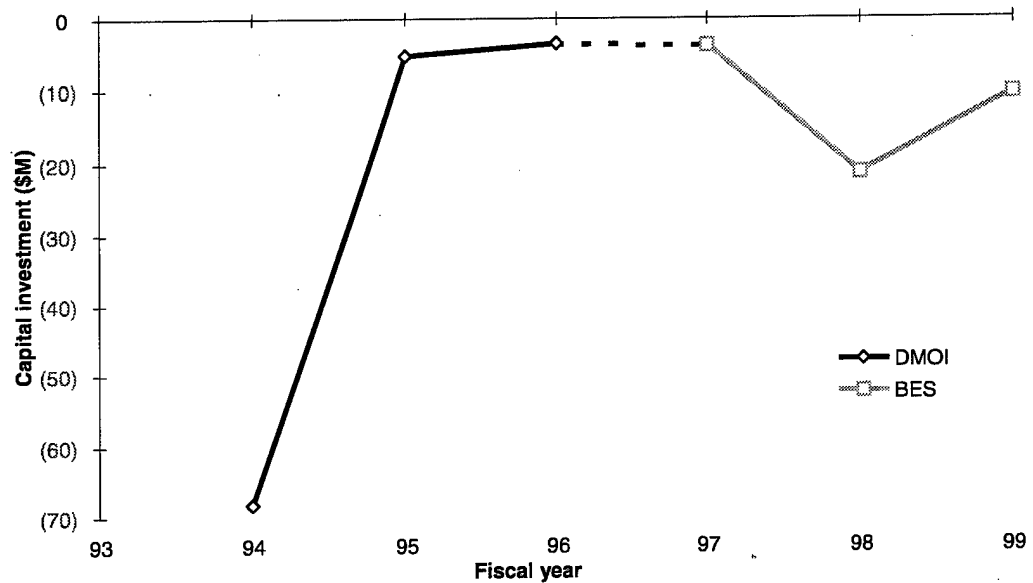


Figure A-23. Net Capital Investment—NAVSEA



The Marine Corps' performance also was not encouraging (Figures A-24 and A-25). The most recent data indicate a decreasing trend in throughput, while capital investment hovered around zero. The observation is that throughput decreased at a greater rate than assets.

Figure A-24. Capital Effectiveness Ratio—Marine Corps

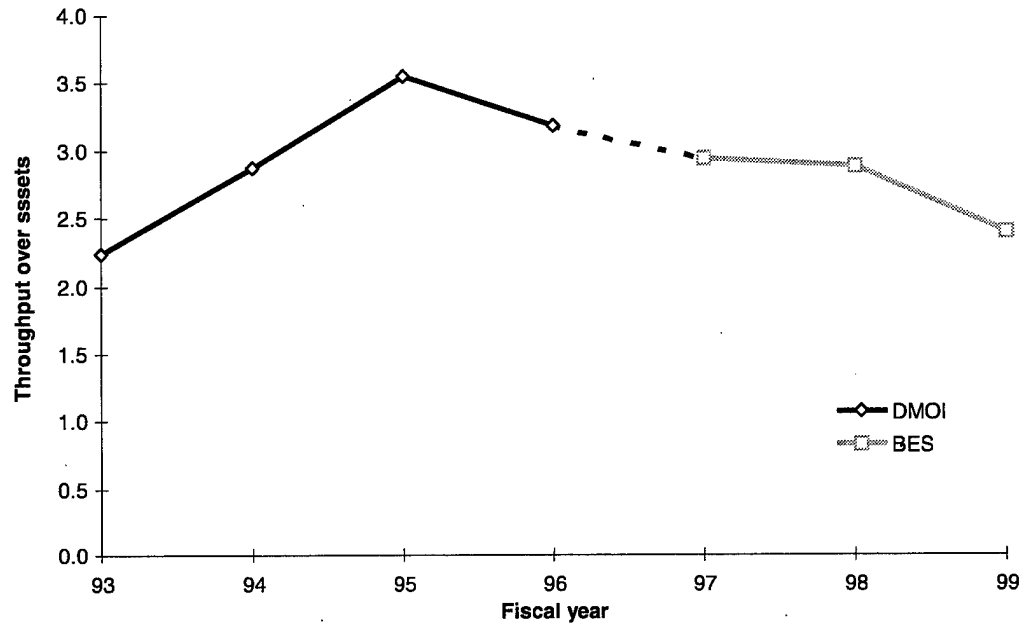
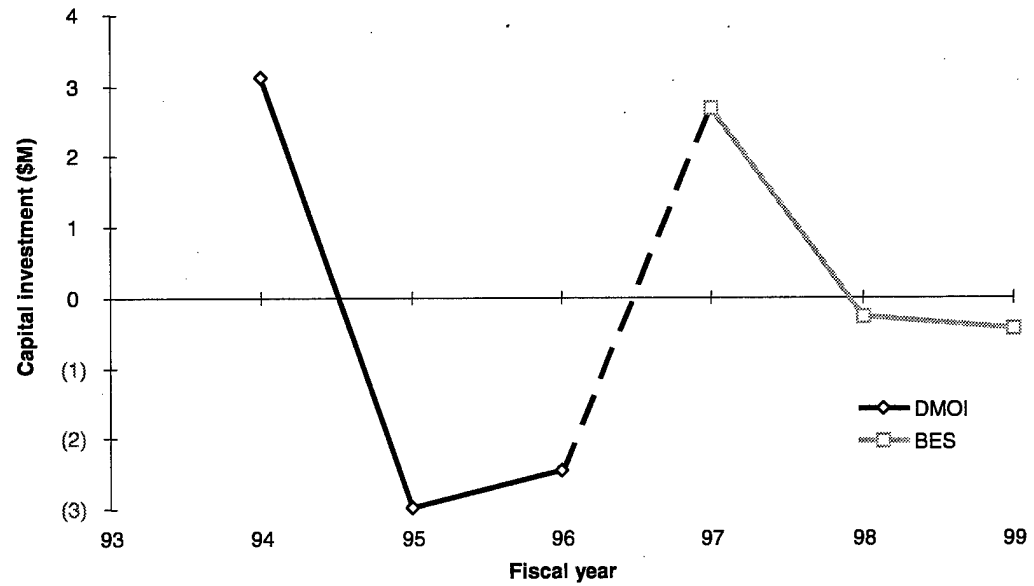


Figure A-25. Net Capital Investment—Marine Corps

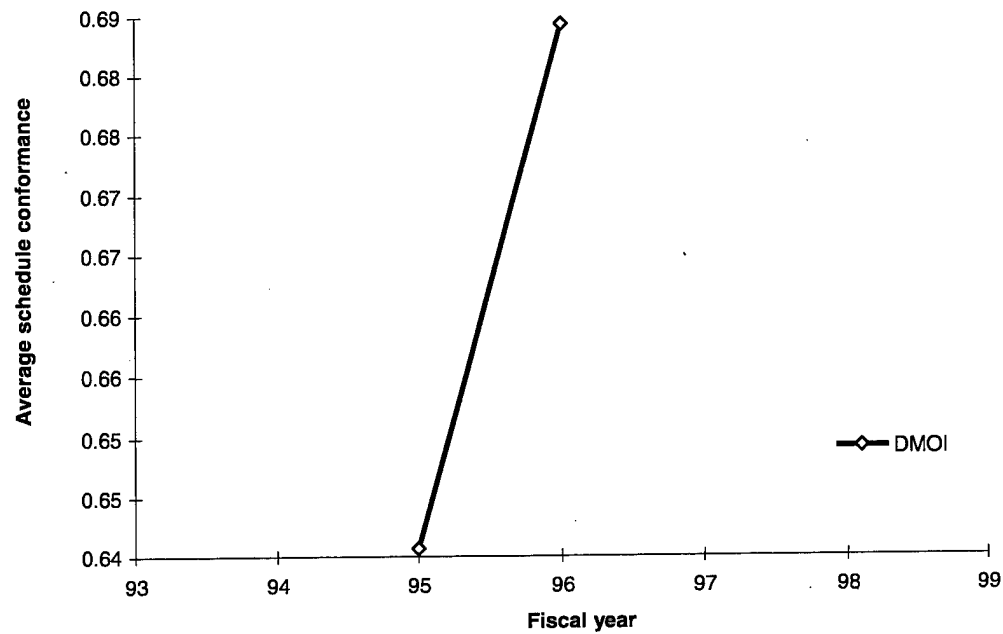


QUALITY

The quality metric, schedule conformance, results are shown below for each Service.

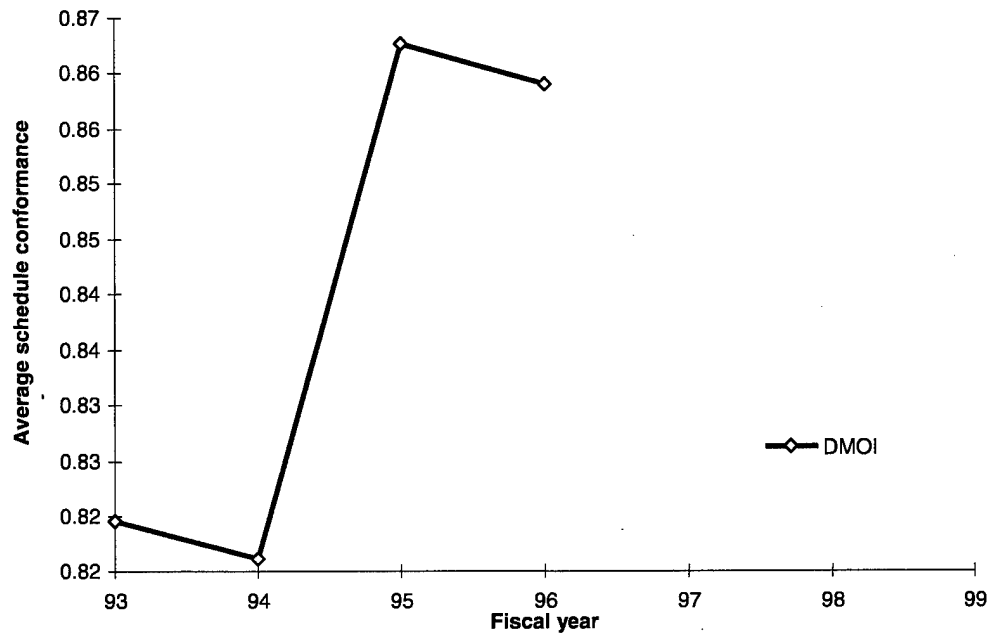
The Army's average schedule conformance increased from FY95 to FY96 (Figure A-26); however, with only two data points available, it would be premature to call this a trend.

Figure A-26. Schedule Conformance—Army



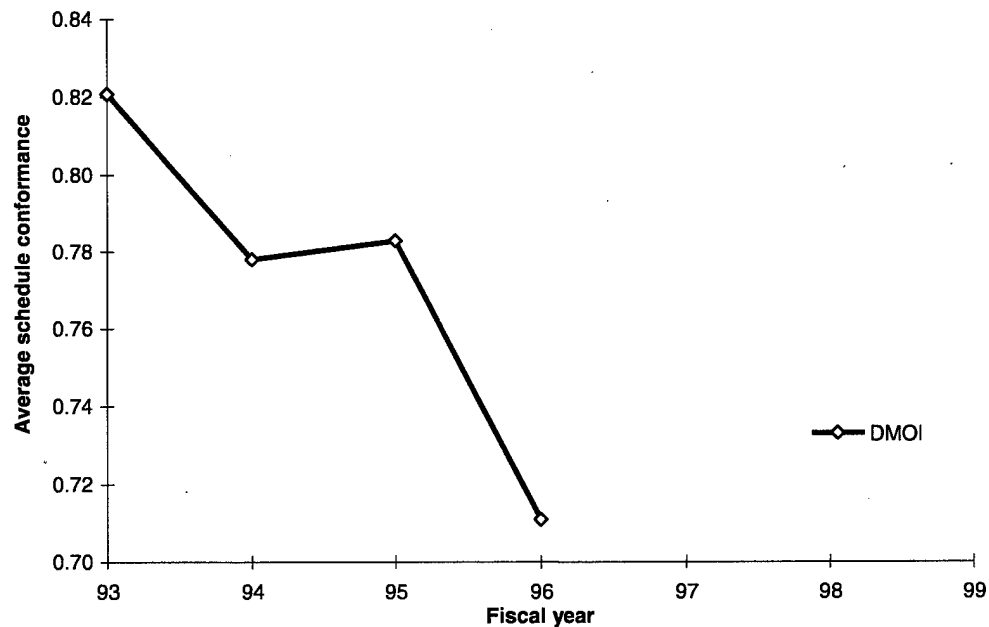
The Air Force schedule conformance appears to have increased (Figure A-27). However, noting the scale of the graph, the change is approximately 5 percent, so quality may be considered constant prior to and following the jump in the FY94–FY95 time frame.

Figure A-27. Schedule Conformance—Air Force



NAVAIR's schedule conformance decreased from FY93–FY96 by approximately 13 percent (Figure A-28). This metric indicates an undesirable trend and highlights an area for improvement, based on the available historical data.

Figure A-28. Schedule Conformance—NAVAIR



As discussed above, NAVSEA and the Marine Corps do not report schedule data, since their end items and logistics systems cause such data to be misrepresentative of true depot performance.

Appendix B

Abbreviations

BES	Budget Estimate Submission
DLA	Defense Logistics Agency
DLC	direct labor cost
DLH	direct labor hours
DMOI	Depot Maintenance Operations Indicators
DoD	Department of Defense
DWCF	Defense Working Capital Fund
FMF	Fleet Marine Forces
G&A	general and administrative
LMI	Logistics Management Institute
MILCON	military construction
NAVAR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
OSD	Office of the Secretary of Defense
POM	Program Objective Memorandum
RPM	real property maintenance
TE	Table of Equipment
USAF	U.S. Air Force
USMC	U.S. Marine Corps
WCF	working capital fund

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13. ABSTRACT (Maximum 200 words) Many Department of Defense support organizations are financed with revolving funds to take advantage of the flexibility offered by them. However, in the appropriations-oriented Defense Programming Review, there has been little visibility of the internal financial operating plans of those support organizations and of the total funding that their customers plan to spend on them. Additionally, even when estimates of available customer funding are made, customers' workload requirements change for a variety of reasons, including changing priorities or national security requirements. This effort focused on the Depot Maintenance business area, one of several support business areas operating as a working capital fund. Metrics were reviewed and recommendations proposed in three primary areas: output, cost, and quality. A major consideration in the research was the sponsor's desire to minimize new data requirements on the Services and agencies; therefore, data availability became a binding constraint on metric development.				
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